DISCOVERY

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DISCOVERY

EDITOR: Anthony R. Michaelis, Ph.D., B.Sc. EDITORIAL OFFICE: 244 High Holborn, W.C.1. CHAncery 6518
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CONTENTS

COVER PICTURE: A composite picture of printed circuits which are beginning to take an important place in electronic engineering. The design was based on printed circuits as manufactured by the Telegraph Condenser Co. Ltd, one of the leading manufacturers in this country.

THE PROGRESS OF SCIENCE

J. J. THOMSON AS A TRUSTEE OF *DISCOVERY*

We celebrate this year the centenary of the birth of Sir J. J. Thomson. We are proud that one of the greatest physicists of our time was one of the original trustees of DISCOVERY when the first issue was published by John Murray in January 1920. In April 1938 DISCOVERY was transferred to the Cambridge University Press, and the trusteeship was dissolved. During the intervening eighteen years Sir J. J. Thomson had helped to mould the policy of the journal.

The original aims of DISCOVERY were, in the words of the first Editorial Note, "to interest the reader, not to preach any special doctrine, or to lecture on any particular subject . . . to give readers an interest both in the Sciences and in the Humanities by making the work of the specialists in both as plain as possible". In 1938 the Syndics of the Cambridge University Press put it on record that they wished "to continue DISCOVERY according to their [the Trustees] main principles: first, that the knowledge in it shall be accurate; second, that it shall be as universal as possible. The journal will not be wholly 'scientific' in the narrow sense. . . . There will be as much physics, astronomy, biochemistry, medicine, as we can find room for. Nor shall we neglect the other branches of science. . . . Last, but not least, we must present the knowledge as clearly and attractively as possible."

These aims are rigorous, but DISCOVERY has been in existence now for thirty-seven years, with only a short gap during the war—a fact which proves we have not altogether failed. In reporting the increasing activities of science we are acutely aware of the limitations set upon us by the fact that we must crowd all this ever-extending knowledge into twelve issues a year. Readers interested in a specialised field must realise how difficult it is to keep a balance between the many demands on our space.

A centenary biography of Sir J. J. Thomson has been written specially for DISCOVERY by Dr Derek Price and appears on p. 494 of this issue.

HONOURS FOR MR TOMPKINS

This year's Kalinga Prize—the award which Unesco makes each year for popular science writing—goes to Prof. George Gamow. He is world-famous as the creator of Mr Tompkins, the middle-aged, balding bank clerk whose curiosity in scientific matters led him on a fascinating voyage of discovery into the realms of relativity, modern physics and modern biology. With the aid of John Hookham, the artist, Mr Tompkins was born in 1938 in the columns of DISCOVERY—the first instalment of "Mr Tompkins in Wonderland" was printed in our columns in December 1938. Two other books in the same genre followed, these being entitled "Mr Tompkins Explores the Atom" and "Mr Tompkins Learns the Facts of Life". (All three volumes were published in Britain by Cambridge University Press, who

The original vignette of Mr Tompkins as it appeared also on p. 432 of DISCOVERY, December, 1938.

were also at that time the publishers of DISCOVERY. Fundamentally these were serious works, but all of them were characterised by Gamow's ready wit and his light-hearted style, the latter being intensely reminiscent of the first great scientific populariser, Bernard Le Bovier de Fontenelle, of whom it was said "*cet esprit de légèreté que la plupart des Français aiment à apporter dans les réflexions les plus sérieuses*". His other best-known books include "Atomic Energy in Cosmic and Human Life" and "Birth and Death of the Sun".

Gamow was born in Odessa on March 4, 1904. He was educated at the universities of Leningrad and Göttingen. There he developed the quantum theory of radioactivity, and later he did research with Niels Bohr in Copenhagen and Rutherford in Cambridge. In 1935 he became Professor of Theoretical Physics at the George Washington University in Washington, D.C. In 1956 he was appointed to the staff of the University of Colorado at Boulder as Professor of Physics. Prof. Gamow is serving or has served as scientific adviser to a number of major organisations, including the Bureau of Ordnance, U.S. Navy Department; the Applied Physics Laboratory and the Operational Research Office of Johns Hopkins University; the Los Alamos Scientific Laboratory and the Radiation Laboratory of the University of California; the Air Force Scientific Advisory Board; and Convair, San Diego, Cal. His researches have led to more than a hundred publications in such fields as the theory of radioactive decay and a model of an atomic nucleus, relativistic cosmology and the origin of chemical elements, and the theory of protein synthesis.

HOW MANY HUMAN CHROMOSOMES?

It has long been supposed that the nuclei of human somatic cells contain 48 chromosomes. The first satisfactory count was published in 1912 by de Winiwarter, and his paper was followed in the 'twenties and 'thirties by a dozen or more others. During this period the one

Two photo-micrographs of human chromosomes which were shown by Dr J. H. Tjio at the scientific exhibition during the First Congress of Human Genetics. Above, a late prophase, below, an early metaphase. The preparations were made from explants of human embryonic lungfibroblasts. The lower photograph was first published in *Hereditas*, 1956.

point of controversy concerned the sex-chromosomes. In most species of mammals the males have a pair of morphologically distinct X- and Y-chromosomes concerned with sex determination, while the females have 2 X-chromosomes and no Y. The minority group in the controversy claimed that human males were exceptional in having one X and no Y, and correspondingly an odd number, 47, in their body cells. According to the more general view there were 48 chromosomes in the body cells of both sexes, males being normal XY and females XX. After the Second World War this controversy was forgotten and the number 48 became generally accepted.

Biologists were therefore very surprised, earlier this year, to learn that this number was likely to be wrong. In a short paper published in the Swedish journal *Hereditas*,* J. H. Tjio and A. Levan reported that they had established tissue cultures from 4 human embryos and that the dividing cells in all their cultures regularly contained 46 chromosomes only. At the First International Congress of Human Genetics held recently in Copenhagen, Dr Tjio announced that he had examined preparations from a further 4 embryos, with the same result, and supported this by exhibiting several magnificent photomicrographs of the chromosomes in dividing cells from his cultures. Now, although the possibility of some mechanism by which 2 chromosomes were regularly lost during embryonic development of certain tissues or during growth of the cultures is remote, it should not be disregarded. Tjio and Levan were careful to point this out and to urge that new counts should be made on dividing cells in male gonads as a check. This gap was filled at the same Congress by Dr C. E. Ford and Mr J. L. Hamerton of the Medical Research Council Radiobiological Research Unit at Harwell. Prompted by Tjio and Levan's paper, they had examined preparations of testis tissue and they confirmed the count of 46 in each of the three men from which they obtained specimens. Most of their observations were made at metaphase in primary spermatocytes—cells in which the chromosomes are present in pairs before being halved in number during the process of forming daughter cells which will differentiate into sperm.

How are these reports to be reconciled with the older observations? It has been known for many years that in certain insect species (particularly among the grasshoppers) the chromosome number is not constant but varies from one individual to another. In these species there does not appear to be any change in *amount* of chromosome material: it is merely a matter of the way it is arranged, in general 1, 2, or more V-like chromosomes of one individual being represented by 2, 4, or more rod-like chromosomes in another. Recently a system of this kind has been discovered in a small mammal. It is not impossible, therefore, that there is variation in chromosome number between different human individuals. However, after many counts of 48, punctuated by several 47s, there have now been 11 successive counts of 46, and it would be stretching credulity too far to suppose that such variation could provide the whole answer. The alternative explanation is error. Formerly, chromosome-counting in vertebrate tissues was an exercise in high-power microscopy requiring considerable patience and skill; the chromosomes were more or less closely aggregated in the centre of the cell and there were many opportunities for errors of interpretation. In the last few years several technical devices have been adopted which collectively spread the chromosomes widely within the dividing cell and so make counting almost free from subjective judgment. On technical grounds, therefore, it seems much more likely that most, and perhaps all, of the earlier reports of 47 and 48 were wrong.

At first sight it may seem unimportant whether the correct number is 46 or 48, or whether both occur, together, perhaps, with other numbers. But whether important or trivial it is desirable that the counts should be *right*. There is one respect in which correct information could be important. The cells of malignant growths in certain experimental animals often have abnormal chromosome sets, and there is some evidence that the same may be true in man; but clearly the normal must be known before the abnormal can be recognised.

* "The Chromosome Number of Man". 1956, vol. 42, pp. 1–6.

AVIATION MEDICINE IN ENGLAND AND AMERICA

Since the Second World War the interest of the general public in problems of high altitude and space flight has become increasingly evident. It is unfortunate, however, that this new sphere of exploration of the upper atmosphere and space has been such a fertile field for the minds of imaginative authors, who lack the necessary background to give a true setting for their characters. The high cost of upper atmospheric research can only be borne by a government itself, and in addition, the information gained has tremendous military significance. The consequent reluctance to release true and accurate information has fostered those authors with imagination. Their products have found a ready market with a hungry public but one now detects a change, in that discriminating readers are demanding factual information on this topic. This year has seen the release of an almost documentary film in American style entitled "Threshold of Space", and more recently, the publication of a new book for general consumption called "Men, Rockets and Space".* The material it contains is purely factual and the ideas expressed represent the views of experts in their respective sciences. One is astonished to find, however, that reputable scientists have permitted their extensive interviews, recorded on dictaphones, to be used freely and interpreted by the author in this manner.

The book is American in its origin and outlook, particularly in its dramatic approach and style. The reader is left in no doubt about this fact, and the uncritical mind may gain the impression that space medicine research has originated and developed in America alone, whilst the rest of the world stood still. The biased nature of this account of exploration of the upper atmosphere, however, is offset by the surprisingly accurate

* "Men, Rockets and Space" by Lloyd Mallan (London, Cassell and Co. Ltd. 1956, 302 pp., 18*s*.)

treatment it is given. The honours bestowed on the pioneers described do not leave the shores of America, and no blushes are spared. The work of Wright Field is described so authentically that one feels that one can learn almost as much from the book as can be gained by a personal visit to that area, with its limits on security and zealous escorts and guides. Nevertheless, despite these security problems, a very generous treatment is given to the fundamental scientific problems of rocket research and aviation medicine. We learn how much space was covered by these early American pioneers with the aid only of a few yards of steel pipe and an abundance of high explosive. One is left with the feeling that the story of the much earlier German work on rocket research might prove interesting reading also, particularly as many people in this country have reason to remember the advanced stage of the V2 by 1944, after which time this vehicle became the property of the Allies and served peaceful ends on the rocket testing grounds of the United States. There is no doubt that with regard to high-altitude rocket research since the war, America has contributed more than any country in the world.

A great part of the book necessarily deals with the human factors involved in high-altitude and high-speed flight, and it is here that the author has been more careful with his data. This he has related directly to the personalities he has interviewed. Aviation and space medicine are presented in what amounts to a series of excellent biographies, which, however, are by no means complete; and the gaps left in the personalities involved lead significantly to a lack of balance and could give rise to comment even in America itself. This is particularly so because much of the basic information required for the development of oxygen equipment, for example, was the result of combined research efforts and interchange of ideas between this country, America, and Canada. Bazett, who first solved the problem of high-pressure breathing is mentioned, but the fact that he was British and also worked in Canada and at the Institute of Aviation Medicine, Farnborough, during the later war years, is overlooked. It was whilst he was at Farnborough in England in 1942 and 1943, when he was over fifty years of age, that he demonstrated on himself in the high-altitude decompression chamber the effectiveness of his equipment at simulated altitudes of 52,000 feet. The author, however, describes at length and with considerable drama, similar later experiments by Dr Henry at Wright Field to prove these principles to his own authorities. The names involved are now legend, but it is surprising also that in the matter of human tolerance to acceleration the brilliant work of the Mayo Aeromedical Unit during the war is overlooked, as are the contributions of the Institute of Aviation Medicine at Toronto. Paul Stapp's outstanding work on human tolerance to crash decelerations is described in fifteen pages, and on page 87 one is faced with the statement, ". . . rocket powered deceleration sled at Muroc was the first of its kind in the world . . .". This statement is difficult to understand in view of the fact that live runs had been carried out on the rocket powered deceleration sled at Farnborough almost ten years previously during the war. It was these early experiments in England which proved to us the principles and led to the final development of the crash safety harness and backward-facing seats used even at the present time in service aircraft. Again, we find only passing reference to the early German and British work on ejection seats, although it was the co-operation of the team at the Institute of Aviation Medicine, Farnborough, with Mr James Martin of the Martin Baker Aircraft Company, Denham, which enabled the limits of tolerance to vertical impact accelerations for human subjects to be determined, and led to the development of the first satisfactory and safe ejection seat.

Attention has been drawn to these few examples, not to detract from the book, but in order to help the reader to place it in its true perspective. The part of the story told is, with few exceptions true, and because of this it is powerful and dramatic. It is history worth recording and the reader will be left wanting the remainder.

DIRECT CURRENT ACROSS THE CHANNEL

In certain aspects of scientific progress there is legitimate complaint to be made that progress is almost too rapid to be assimilated by all those interested in the particular field concerned. In electrical engineering this is perhaps true of the electronic side of the industry, in regard to light-current equipment, such as radar, electron microscopes, and equipment of like nature. In the heavy-current side, however, progress is apt to be very considerably slower than might reasonably be anticipated. It is true that those charged with the duty of designing items of capital equipment costing up to a million pounds per unit must naturally advance with caution, and those who have to operate equipment used in the public electricity supply service are also very properly cautious of innovation until the new equipment has in some way proved itself in rigorous service.

A case in point, to illustrate the slowness with which a new idea has been brought to the stage of large-scale practical application, is provided by the recent announcement that at long last a start is to be made on the power cable across the Straits of Dover, designed to link the British and French electricity supply systems. It has finally been decided that the cable will operate on the high-voltage direct-current principle.

As far back as the early days of the present century, a successful high-voltage direct-current power transmission scheme was in operation in France, built to the designs of the late M. Thury. The advantages of direct current over alternating current were well known; the need for only two conductors (or a single conductor with earth return) instead of the three wires needed for the three-phase a.c. system; the fact that the peak of the alternating current wave necessitated a degree of insulation, to resist this peak, greater than that of the effective, or useful voltage, which is the root-mean-square value of the peak figure; the difficulty of controlling load-flows with alternating current; and the advantage of abolishing the capacitance losses in the insulation. But the ease of transformation of voltage inherent in an a.c.

system won the day. Nevertheless, over the last fifty years there have always been engineers who felt that the proper method of transmitting large blocks of power was to use direct current. In Sweden, the direct current flame burnt particularly strongly, and the name of Dr Uno Lamm, who for the last 20 years has devoted his great talents to research in this field, will always be honoured for his patient development work into the large electronic valves needed for the high voltages and heavy currents necessary for successful d.c. transmission projects.

During the war the Germans developed high-voltage direct-current equipment and were about to commission a 400,000-volt scheme when Allied victory prevented it and the plant was taken to Russia. In Sweden, in 1954, the first major transmission scheme operating on d.c. was put into service, coupling the Island of Gotland with the mainland of Sweden, through a submarine cable 62 miles long, working at 100 kV to earth and carrying 20,000 kW of power. In Russia, just previous to this, a scheme 70 miles long, between Kashira and Moscow, had been put into service, to carry 30,000 kW at 200,000 volts between poles.

In spite of the obvious advantages of direct current by way of economy of material and ease of control, especially when applied to a link between two great power systems such as those of England and France, the joint committee of the British Electricity Authority and Electricité de France reporting in 1954 felt that reliance could not yet be placed on the large electronic valves used for converting a.c. to d.c. and vice versa, and they advised, against the weight of international expert opinion, that an a.c. link of 100,000 kW capacity, employing three separate cables, should be employed.

The slow change in engineering opinion as to the reliability of high-voltage direct-current equipment has at length reached the stage where it has been possible to envisage a d.c. link of 150,000 kW, operating at 200,000 volts, which will cost about £4 million and which will be ready to provide the benefits of exchange of peak load between the two countries, with their differing electrical characteristics, by about 1960.

A SUBSTITUTE FOR INSULIN

Although insulin is a satisfactory means of controlling sugar diabetes (diabetes mellitus) when given in conjunction with a suitable diet, it has one important drawback. It must be given by subcutaneous injection since it is inactive by mouth. The possibility of an oral treatment for diabetes has therefore always been attractive. Unfortunately a great number of synthetic drugs cause blood disorders and other side-effects when given over a long period; and any substance, no matter how valuable it may be in lowering the blood sugar at first, may later be rendered useless because of some long-term toxic effect. One such product, which originated in Germany before the last war, was called Synthalin. It reduced the blood sugar, but it had a toxic effect on the liver and its use was abandoned.

In October last year two groups of German physicians announced the discovery of a new antidiabetic substance chemically known as sulphanilyl-n-butylurea, or, more commonly, BZ55. Not unnaturally these reports aroused world-wide interest. However, it appears that in Germany dietary control of diabetes is less often attempted than in this country and America. That is to say, patients in British clinics may often be fed on diets which render a compound like BZ55 unnecessary. Nevertheless it looked as if BZ55 might be useful for older patients who still needed a little insulin.

Through Eli Lilly and Co. and the British Insulin Manufacturers' Association, an organisation which comprises Boots Pure Drug Co., Burroughs, Wellcome and Co., Allen and Hanbury's Ltd., and British Drug Houses Ltd., a number of investigational groups obtained supplies of BZ55 for clinical trial. Their findings are reported in the *British Medical Journal* for August 25, and are unanimous in several respects. BZ55 will control the blood sugar in diabetic patients over the age of forty when dieting alone is not adequate. Patients, no matter what their age, who have at some time suffered from a diabetes complication known as ketonuria (acetone substances in the urine) will not respond.

At first sight these results are impressive, and BZ55 would represent a really outstanding discovery but for one thing. Toxic effects even in the relatively short trials period were significant enough to arouse doubts as to whether BZ55 would after all be of any value in diabetes. These side-effects were on the whole minor, and took the form of rashes and alterations in the blood, although the original German reports stated that there were no changes of this nature. A reduction in white blood cells (leucopenia) was noticed in some patients treated in Britain and the United States. One death from allergy and one from agranulocytosis (a more severe form of leucopenia) have been reported. BZ55 is a sulphonamide; and the sulphonamides are notorious for causing such side-effects.

A derivative of BZ55 known as D860 or Orinase, paratolyl-sulphonyl-n-butylurea has been developed, and this is not a sulphonamide. First reports show that it is as effective as BZ55 and it may have less tendency to produce skin reactions or changes in the blood. Trials of this new compound are now under way in this country.

The mode of action of both BZ55 and D860 is imperfectly understood. It has been suggested that they may interfere with the production of another pancreatic hormone, glucagon, which is known to raise the blood sugar. Another supposition is that they prevent the destruction of insulin or increase its activity by an action on the enzymes which normally destroy it in the body, since it seems certain that some insulin must be present if these drugs are to work.

It has also been noted that many antibacterial substances (as well as BZ55) have a hypoglycaemic action, among them penicillin and the sulphonamides, and that there might be a relation between the two actions. It has also been supposed that the bacteria present in an organ such as the liver might, through an enzyme insulinase which they secrete, be responsible for the destruction of insulin. This theory, however, cannot at the moment explain why D860 should be an effective

antidiabetic agent when in contrast to BZ55 it has no antibacterial properties.

BZ55 and D860 are undoubtedly drugs of great importance, although perhaps with limitations which at the moment preclude them from being used outside certain investigational centres in this country where patients can be carefully observed.

As for insulin itself, constant research is developing new and more satisfactory forms. Even here there is a faint possibility of dispensing with injections, since there have been some favourable results from its administration in the form of an aerosol.

PROBLEMS OF SOCIAL CHANGE

Those who are alert to developments in public thinking and in everyday language may have noticed the increasing use of the word sociology in a wide range of contexts. Close on the heels of psychology the world is recognising the even younger science of sociology, which in many countries is firmly established and rapidly expanding not only as an academic discipline but also in a great variety of research institutions and agencies.

The speed and the extent of growth of professional sociology can be partly gauged by the success of the Third World Congress of Sociology, held in Amsterdam between August 22 and 29 of this year, which attracted over 500 participants, drawn from fifty-six countries in all parts of the world. What had six years ago started as something of a family affair was now genuinely a congress of the world's authorities on sociological matters.

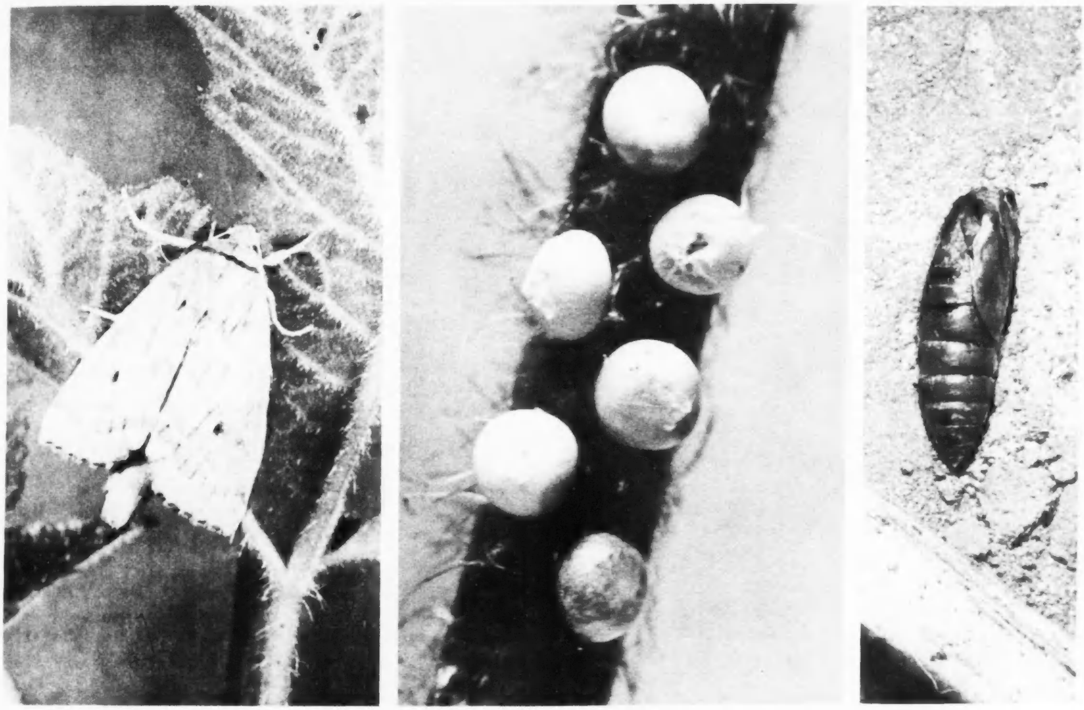
The general theme chosen was "Problems of Social Change in the 20th Century", and the design of the programme was such that an opportunity was given to proceed from topics of very great generality through an intermediate stage to rather detailed papers describing actual pieces of work. For example, the idea of changing family structure, implicit in the initial broad statements, was made the central theme in one plenary session and subsequently broken down in detail in three parallel discussion groups to which some speakers contributed brief accounts of their actual research in the field in question. Other important ideas, such as changes in property relations, the dynamics of social class, education and social mobility, were similarly treated.

It can be said that provision was made for the airing of a large number of important subjects. At the same time this kind of framework gives latitude for a serious lack of coherence in the discussion. This was remarked upon by several of the chairmen of sessions, who found it hard to organise any proper continuity or cut and thrust of debate. Many sessions trailed along as a series of prepared statements. This was partly the result of language difficulties, but it is a sad reflection on the variety of independent theories at present in active use in sociological circles that rather few of these statements either confirmed or confuted each other.

The contributions also revealed that there is still much confusion, or at least much trans-national disagreement, as to where the orbit of sociology lies. Particularly at the first broad sessions of the Congress, we were exposed to some very general speeches which, to one listener at least, added little to sociology as a science able to offer a predictive grasp of social processes. All later sessions tended to be dominated by a second type of paper, a kind of descriptive sociology—what might be called contemporary history—much of which derived more from everyday common-sense concepts that from sociology's established theories and methods, such as they are. These tended to obscure the still isolated but rapidly growing solid footholds of empirical investigation, and the first signs of a common language, which were only adequately introduced at one of the last sessions devoted to current trends in sociological research. The popularity of this session surprised the secretariat and necessitated a move from a small lecture room to the great hall. Here certain common lines of approach began to appear—in which the experiences of various speakers began to reinforce each other and to suggest a convergence not only on questions of method but also on the particular middle-level theories on which fruitful empirical explanations depend. For example, three or four speakers specifically remarked on the usefulness of the concept of the reference group, i.e. the group from which the individual derives his standards, which often helps to account for vagaries in human satisfactions and habits so much more effectively than can be explained by direct differences in physical circumstances.

A description of the climate of the Congress would be incomplete without a mention of the impact of the strong delegation from the U.S.S.R. and of other participants from Eastern Europe. It is more than a century since socialism and sociology offered their rival wares to a revolutionary decade, and this first formal moment of rapprochement was a moment in history. Not unnaturally, the situation aroused immense interest on both sides. Several sessions developed into an avid series of inquiries about conditions in the Soviet Union and various supernumerary sessions were arranged for this purpose, and for the novel experience of disputing marxism with Soviet marxists. These debates were concerned with social philosophy and social institutions, but hardly at all with sociology in its modern western forms. It seems probable that the empirical social sciences in the western sense exist in the Soviet Union only in embryonic form, but it was noticeable that speakers from other Eastern European countries, whose communications with the West were interrupted later and for a shorter period than was the case with the Soviet Union, showed a greater appreciation of the potential contribution of empirical sociology to social action. It is clear that the possibilities of rapprochement exist, but it is difficult to discern whether, and if so in what manner, it will develop.

Other national and cultural differences of a less acute type were also in evidence. The United States, the home and haven of empirical sociology and the birthplace of many theories, both middle-level and systematic, was strongly represented. Theirs has been a major contribution and has provided much of the foundation for empirical sociology throughout the world. But it is a



Left, female moth, magnification approx. ×11·3. *Centre*, eggs attached to plant stem; magnified approx. ×10. *Right*, a pupa, magnified approx. ×11·5.

healthy sign that other centres of scholarship, particularly perhaps in Northern Europe, while accepting the main lines of growth of American sociology are applying themselves constructively to the task of clarifying and refining the concepts and methods of this new discipline.

As with many international conferences, the function of cross-fertilisation is probably performed most fruitfully through the informal groups that such a gathering makes possible. It is a memorable experience to make contact with scholars from all over the world who have previously been only names on title pages. In this instance the pleasure of many such meetings was reinforced by the excitement of exposure to the atmosphere of intellectual ferment and of incipient pragmatic mastery that is beginning to characterise the new sociology.

A NEW MOTH IN SOUTHERN ENGLAND

A large moth with fore wings of a buff-cream shade and paler hind wings has aroused interest amongst British entomologists. The species is called *Hydraecia hucherardi*, Mab. (it has no official English title) and it was not recorded in this country until the autumn of 1952, when a male example was found on a street lamp at Hailsham, Sussex, by Mr David Saunders. The next specimen was seen in 1953 among reeds growing in Romney Marsh, and was a female; later that year several more examples were caught in the Dungeness area. The discoveries led other moth enthusiasts to make a thorough search of likely localities in both Kent and Sussex, and eventually it was found that the moth originates from a larva that feeds inside the stems and roots of marsh-mallow (*Althaea officinalis*), a tall plant with pale rose flowers rather like a small hollyhock.

The larva, or caterpillar, is a pale, grub-like creature, and on becoming fully grown in late July it leaves the roots and stems of the marsh-mallow and changes into a brown pupa a few inches below the surface of the adjacent soil. Since 1953 a number of larvae have been collected and reared in captivity, and moths have been taken on the wing by night and found resting amongst the plants by day. Although no English name has yet been given to the species, it might well be called the marsh-mallow moth. It seems remarkable that this large, conspicuous moth was previously overlooked in areas which are so well known to entomologists. The species is harmless to crops and cultivated plants, and it is hoped that it will continue to flourish here. It is found in suitable areas in various parts of Europe, but until the recent investigation by British entomologists little seems to have been recorded about its early stages and general habits. The photographs were taken by Mr George E. Hyde, who sent us this note.

SIR J. J. THOMSON, O.M., F.R.S.

A CENTENARY BIOGRAPHY

D. J. PRICE, Ph.D.
Christ's College, Cambridge

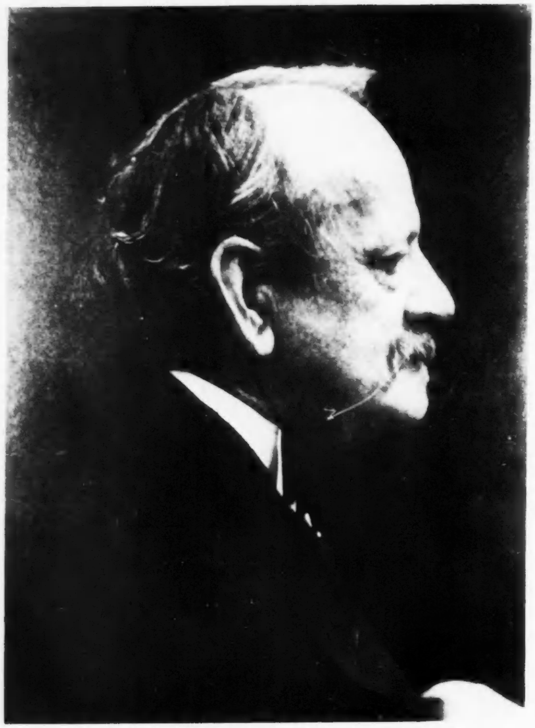


FIG. 1. Sir J. J. Thomson, O.M., F.R.S. 1856–1940

On December 18 of this year we celebrate the centenary of the birth of one of the most remarkable physicists of our time. He might have been classed as a narrow specialist in the field of electric discharge in gases, yet he rode the crest of the wave that brought in all the crowded advances of modern physics. Many people thought him a typical example of the absent-minded professor—yet he proved wise and skilled as an administrator in his Mastership of Trinity College, and he would have made a first-class financier or business man. Most important of all, and perhaps nearer to his heart than his own career and scientific work, was his part in building up the great school of physics at the Cavendish Laboratory at Cambridge University. A large and distinguished portion of the physicists working today are pupils once or twice removed of men who were taught by Sir J. J. Thomson or who worked with him in those epoch-making years.

Joseph John Thomson was born in 1856 at Cheetham Hill, a suburb of Manchester. His father carried on the family business of bookseller and publisher. Thus the boy grew up in an atmosphere of books. Amongst the teachers at Owens College, Manchester, where he went at the age of 14, there were Osborne Reynolds, who taught Thomson's main subject of engineering, Balfour Stewart for physics, Roscoe for chemistry, and Thomas Barker for mathematics. Barker taught Thomson quarternions—then the key to all mathematical physics—before the boy had learnt Cartesian geometry. Stewart considered him his best and most promising pupil. Under Stewart's influence the young Thomson wrote his first scientific paper on a question concerning the transformation of energy from one form to another.

Two years after he entered Owens College, Thomson's father died, leaving his mother and a younger brother. The future physicist won a number of scholarships and was able to complete his studies. Towards the end of his time at the College, at the age of 20, he made his first contribution to the *Proceedings of the Royal Society* with an experimental paper on contact electricity of insulators. He entered Trinity College as a Minor Scholar in 1876. The Cambridge Mathematical Tripos was, at that time, a powerful institution, retaining all the glory and stimulus it had from the days of Newton; but physics, and particularly experimental physics, was a novelty not long past the embryonic stage and a subject principally for post-graduate students who had already proved their worth as mathematicians.

Thomson attended the College mathematical lectures given by Thomas Dale, J. W. L. Glaisher, and W. D. Niven. Like so many other distinguished mathematicians, he "coached" with that great teacher Routh. During his undergraduate career he attended the lectures of Professors Adams, Cayley, and Stokes, the last of whom he found clearest and most enjoyable. Throughout these years his training was predominantly that of a pure mathematician.

In January 1880 he took the Tripos examination and came out as second wrangler. Having already published two papers on pure mathematics, he set himself more

resolutely towards physics by entering the Cavendish Laboratory and by preparing a thesis for the fellowship of Trinity College. This thesis had probably first come into his mind while he was still at Owens College, but it had remained dormant during his undergraduate study. The chief content of it was the application of mathematical methods to the study of physical problems involving the transformation of energy. First appearing as his thesis, it was later made the basis for two papers in the *Philosophical Transactions of the Royal Society* for his book "The Application of Dynamics to Physics and Chemistry", and for several other writings.

For the next four years much of J. J. Thomson's time was spent in teaching mathematics to undergraduates, first privately, then as a College Fellow and Lecturer, lastly as University Lecturer.

It is hard to realise that until about a century ago there was no such thing as a public university laboratory. Several scientists had possessed their own relatively small collections of instruments; and national institutions, such as the Royal Society of London, the Accademia del Cimento, and the Paris Académie des Sciences, had made large collections of apparatus used in their researches and experiments. Before the middle of the 19th century the scientists themselves were either gentlemen amateurs of independent means, or they were professional men whose interests happened to become experimental. Such people could buy any instruments needed from the large numbers of specialist mechanics, who also made sundials, telescopes, and other devices of more general application. By about 1850, instruments had become more varied, more complicated, and more costly, and the advancing front of science and its industrial applications was leading more people to take a practical interest in experimental work. By about 1870, Chemical Laboratories were flourishing at many universities. It was conceded that some experimental facilities might be useful in other disciplines of science, and that apparatus was too expensive to be owned privately and too complex to be used efficiently without formal instruction. Physical laboratories came into being elsewhere in Britain. The first was William Thomson's (Lord Kelvin) in Glasgow, and others followed at University College and King's College in London and at the University of Oxford. In Cambridge, a Newtonian bias towards the mathematical approach led to a lack of sympathy with "time-wasting" experiments, and its slowness in following suit was partly due to the "usual Cambridge reason" (as J. J. Thomson later called it), the lack of funds.

In 1870, Cambridge received a benefaction from the Chancellor of the University, the seventh Duke of Devonshire, descendant of the great Henry Cavendish. In the following year, James Clerk Maxwell was appointed as the first Cavendish Professor. The Cavendish Laboratory was opened in 1874, and Maxwell continued there until his death in 1879—a year before J. J. Thomson took his degree.

The University eventually persuaded Lord Rayleigh to continue the professorship, though only for five years; he had his own private laboratory and did not want to tie himself down. For four years Thomson worked in the laboratory under Rayleigh, at whose suggestion he tackled the problem of electrostatic effects between the primary and secondary of an induction coil. Afterwards, again at Rayleigh's suggestion, he started a much more fundamental and difficult research on the ratio of electrostatic and electromagnetic units—a ratio which Maxwell's theory suggests should be equal to the velocity of light. Rayleigh had himself already constructed apparatus and begun to plan the research, but, as he said in later years, "Thomson rather ran away with it". The experimental research resulted in a value about 1% lower than that found by other workers, and Thomson was not satisfied by it. He came back to the problem about seven years later, and, in collaboration with G. F. C. Searle, detected the sources of error.

Throughout this period, Thomson was working primarily as a mathematician, and his unsuccessful application for the Chair in Applied Mathematics at Owens College shows that he was considering his career along this line. His interest in physics was centred on the theory of electricity and magnetism, where he had been much stimulated by the work of Maxwell, and it is clear from his earlier work at the Cavendish that this was the direction in which he wanted to go. Although the researches to which he was directed by Rayleigh may have given him much useful acquaintance with experimental apparatus, they cannot have been much to his taste. If Rayleigh had not been firm in retiring at the end of his stipulated five years, there is little doubt that Thomson would have tired of these quantitative determinations and retreated into his mathematical investigations.

THE YOUNG CAVENDISH PROFESSOR

At the end of 1884, the University had to find a new Cavendish Professor. Lord Kelvin, already approached twice, once more decided not to leave Glasgow. It was expected that R. T. Glazebrook or W. N. Shaw would be chosen, but, to the surprise of all but the electors, J. J. Thomson was elected at the age of 28. He had recently been in the academic public eye, having just been added to the ranks of Fellowship of the Royal Society, but he was justifiably regarded as a mathematician rather than an experimental physicist. Senior members of the University felt that things had come to a pretty pass when mere boys were made professors, and Thomson himself admits:

> "I had sent in my name as a candidate without dreaming that I should be elected, and without serious consideration of the work and responsibility involved. When, after my election, I went into these, I was dismayed. I felt like a fisherman who, with light tackle, had casually cast a line into an unlikely spot and hooked a fish much too heavy for him to land."

It must be admitted that in 1884 the appointment did little to help the shaky prestige of the Cavendish Laboratory. Experimentation was still regarded as a waste of time for people who might have been making a scholarly contribution in mathematics. In his day, Maxwell had been regarded as a very minor professor

in a very remote and specialised department of knowledge. Lord Rayleigh had regarded the laboratory principally as a source of cheap labour for a national physical laboratory (which was not yet then in existence). It took the young Professor Thomson ten years to consolidate the laboratory and his own position.

Thomson's marriage was for him of more than personal significance. When he was elected to the Chair there was still great controversy about the admission of women to the university lectures and degrees, and men were required to vacate their college fellowships on marriage. It was strongly felt that women would be a great distraction to the proper work of scholars, and Thomson may be said to have proved this point, for in 1889 he became engaged to one of the first of his women research students, a Miss Rose Paget, daughter of Sir George Paget, Regius Professor of Physics in the University. She had been working on the problem of soap films thrown into stationary vibrations by the action of sound-waves; it was apparently a trivial piece of work, but the Professor gave her special supervision until, one day, both came downstairs rather flushed, and the research was never continued. They were married in 1890 and became one of the very few young married couples in senior academic circles of Cambridge. In 1893, the Cavendish Physical Society was founded as an informal discussion group, and Mrs Thomson ably supported her husband.

Gradually one line of study began to occupy Thomson's attention above all others. In 1893 he published a book, "Recent Researches in Electricity and Magnetism", which was intended as a sequel to Maxwell's treatise on "Electricity and Magnetism", bringing the subject up to date and summarising the state of knowledge. The most original part of Thomson's book was undoubtedly a chapter on the discharge of electricity through gases—the first detailed account of this subject in English. Furthermore, Thomson was still much inspired by Maxwell's work, both on the kinetic theory of gases and on electromagnetic theory—the latter having reached general acceptance and popularity by the confirmation provided by Hertz's work on electric waves, published in 1887, just previously. In a way, Thomson followed the trend of his time in turning towards the study of all electrical phenomena in gases. Thomson followed Maxwell's half-expressed lead in thinking it likely that the central problems of the theory of electricity and magnetism could best be tackled by further experimental investigation of gases, and beginning his great work at the Cavendish Laboratory, he devoted himself to these ends. During his entire working life, there was scarcely a month when some problem in this field was not engaging his attention.

Although Electric Discharge in Gases looked like being an exciting subject for research at the time, it was almost entirely qualitative and descriptive. Thomson made a number of false starts. The results fell below expectations and did not help much in finding any key to the relations between electricity and the structure of matter. He spent a great deal of time in measuring the speed of propagation of the luminous discharge in a vacuum tube many metres long—a formidable experimental problem with the Toepler vacuum pumps then available. He also made many observations of electrolysis of steam in a gaseous discharge, but found that the hypothesis on which he was working was untenable. Neither research occupies any place in his later writings.

THOMSON'S CHARACTER

At this point it is fitting to examine Thomson's character as an experimentalist and as a leader and teacher in the laboratory. He was not skilful in working with his hands, and many people have described him as being exceptionally clumsy. He seems, however, to have had a genius for understanding the potentialities and limitations of all pieces of apparatus. He knew what devices to construct in order to make some desired observation; he knew how to modify the apparatus to produce further results; he could diagnose any failings and errors and put his finger on the means of correcting such faults. His students and assistants built up and tore down apparatus at his suggestion, and at times the pace must have been feverish and exciting. Perhaps this haste in improvising and modifying apparatus is responsible for the legend of the "sealing-wax and string" methods at the Cavendish Laboratory. Although funds were never lavish, they were usually sufficient, and the improvisations were probably not dictated by poverty, but rather by the fertility and rapid succession of J.J.'s ideas.

Many of the important researches would have been impossible without the devotion and skill of Everett, Thomson's chief helper, and a share in the honour of Thomson's great discoveries rightfully belongs to him.

J.J. was intimately bound up with the life of the laboratory, drawing on the skill and the ideas of his research associates there. He was the sort of man who absorbed ideas, soaking them up during conversations and later being quite unable to recall how the ideas had originated. Although he was always punctilious in giving credit to other workers, he may often have been unaware that part of his ideas had come from other people. This makes it even more difficult than usual to discuss the various priority claims that form a somewhat unsavoury facet of the whole history of modern science. When an idea is in the air, it occurs to several people, and only rarely is an important discovery unique and unattended by very similar work by other hands. In the case of J.J., quite a large part of his major contributions may have been inspired by the work of his students, but this cannot lessen at all the genius of the leader of the laboratory in bringing together and recognising the importance of the field of research as a whole.

THE MIRACULOUS YEARS

It is important to our estimation of the next few miraculous years that we examine closely the position in the laboratory by 1895. By this time, Thomson—or J.J., as he was universally known by then—had become very much of a specialist in this one branch of physics. His was the first generation of men working in such an advanced state of science that narrow specialisation had

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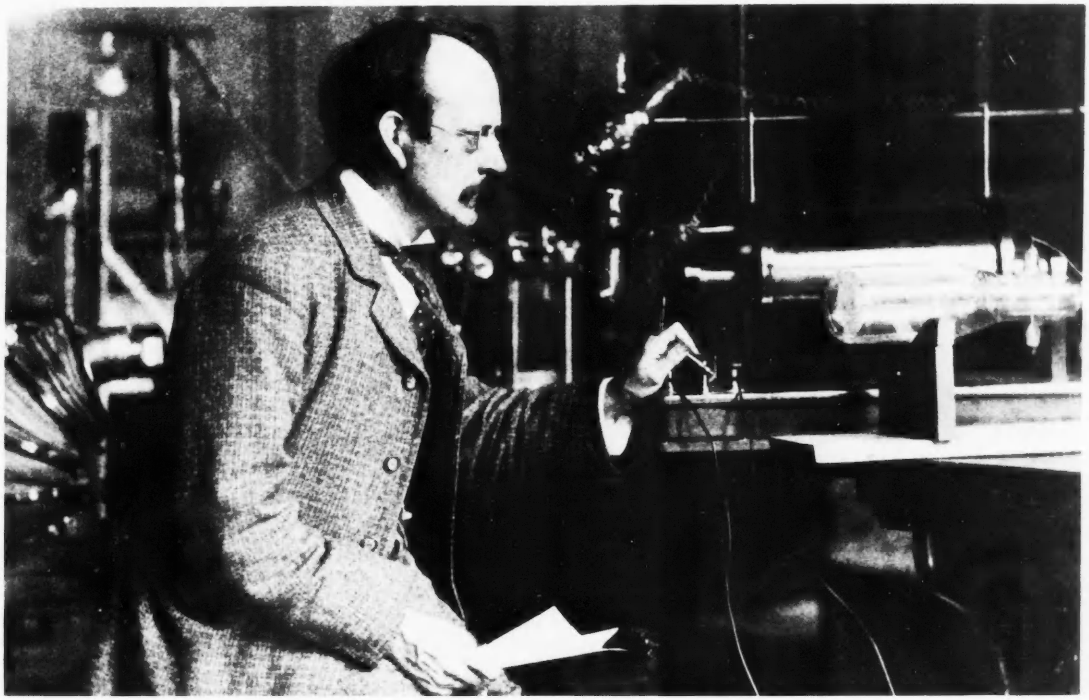

FIG. 2. Experiments on e/m, about 1902.

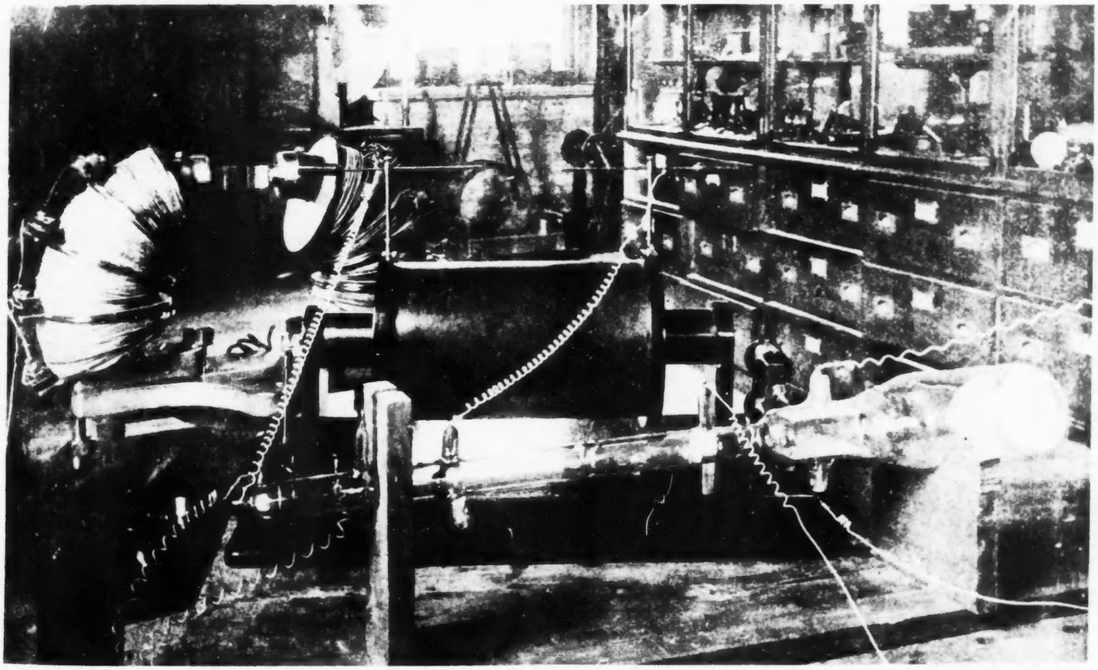

FIG. 3. Another view of the Braun tube used for the later experiments on e/m.

become sufficient and necessary for continued progress. The dangers of specialisation need no elaboration today, but for J.J. and his workers in the Cavendish Laboratory it must be taken as a measure of their inspiration and faith in the subject and in their leader that so much of the effort was turned in this single and, perhaps, rather disappointing subject. It is true that they were not committing themselves or their resources so heavily into the future as one needs to now; nevertheless, the little group of post-graduate mathematicians in the Cavendish had become mobilised around J.J. and his chosen field by 1895. They were ready to ride in on the great tidal waves that broke classical physics asunder and brought in a new era.

Almost as a prelude and preparation for the great discoveries of Roentgen, Becquerel, and Thomson himself, in April 1895 the University introduced new regulations that had the effect of allowing graduate members of other universities to come to Cambridge and to take a degree there. The admission of post-graduate students from outside coincided with the provision of funds which enabled young research workers to take advantage of the opportunity; in 1896 the first awards were made of scholarships provided from the funds which had accumulated from the profits of the London Great Exhibition of 1851; this brought many young scientists towards Cambridge. One of the first was Ernest Rutherford—later to succeed J.J. as Cavendish Professor—and in the same year there was J. S. E. Townsend and J. A. McClelland. The new arrivals brought with them fresh inspiration for the laboratory and for the Professor. Thomson was most happy and most inspired as a leader of his research students, and now that the doors had opened wide, the Cavendish rapidly became a great centre for physical research and teaching. In spite of home-grown geniuses, the tradition of Newton was showing signs of being insufficient for the purposes of advancing science. The infusion of new blood under their young professor was exactly what was needed in Cambridge.

Few people can today recall the tremendous excitement that attended Roentgen's announcement of x-rays, early in 1896. It was, perhaps, the first discovery in physics that created a public sensation and reached the headlines of newspapers. From the middle of January until late in March, every paper and journal carried reports and gross exaggerations about the new rays. Every laboratory where glass could be blown and where physical apparatus was available was turned to studying the new phenomena and taking radiographs for their own and the public's edification, and for the medical men, who were quick to seize the possibilities of photographing the living bone. Indeed, much damage was unknowingly done by the hour-long exposures then necessary.

A rather reserved comment appeared in *Nature* on January 16. A week later a full translation of the original paper was published. By then, x-rays had been demonstrated by J.J. at a meeting of the Cavendish Physical Society, and the first hand to be photographed (that of the wife of Dr G. F. C. Searle) showed an unsuspected broken bone. But the real interest for Thomson lay in the application of x-rays to his own special field. Thomson reports it thus: "I had a copy of the apparatus made and set up at the laboratory, and the first thing I did with it was to see what effect the passage of these rays through a gas would produce on its electrical properties."

He found that the effect was to make the gas a ready conductor of electricity, due to the ionisation produced. This was of vital importance to his researches, for he had long realised that the greatest difficulties in working with discharge in gases lay in the violence of the methods used to induce a discharge. The effect of electrodes he had been able to avoid by the use of induced electrodeless discharges, but before the coming of x-rays he had been unable to make electricity pass through a gas without applying very great electric forces to break it down or by using hot gases and flames—all methods to which accurate methods of measurement were not readily applicable, and the results obtained tended to be capricious. The new phenomenon provided J.J. and the rest of his workers with the fresh technique they needed, and the very existence of this phenomenon raised the problem that was a key to later developments.

The position on the research front of physics just before the discovery of x-rays was curious and especially shaking for those who believed that science dealt with universal and certain truths. There were two camps of physicists with diametrically opposed views as to the nature of the cathode rays—one section, predominantly German physicists, who thought that they were electromagnetic waves of some sort, and another group, including most of the English physicists, who thought they were negatively charged particles. Much could be said in support of either side, and it was very difficult to get any conclusive proof. The greatest objection to the particle view was that the rays could apparently pass through a window of thin aluminium foil, but even here it was countered that the window might be absorbing and re-emitting radiation as a secondary cathode. Then again, if there were particles in discharges of this sort, it was reasonable to suppose that they had been formed in the gas by some process similar to dissociation in a liquid electrolyte. This hypothesis could be tested by examining the spectra given by discharge at either electrode. If dissociation occurred it would be reasonable to expect the negative and positive portions to become segregated and to show different properties. J.J. made several experiments but failed to detect any really significant difference; the carriers, if they were particles, did not seem to be formed by dissociation of the hydrogen molecule.

Experiments with x-rays indicated to Thomson that they had the effect of producing carriers of electricity within the gas, and it now became possible to work with these carriers in the absence of cathode rays. J.J. found that the conductivity produced by the rays did not reach full value immediately the rays were switched on, nor did they stop immediately when the rays were switched off. Further, he found that the conductivity produced could be destroyed by passing the gas through a filter of

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FIG. 4. Measurement of positive-ray parabolas, about 1912.

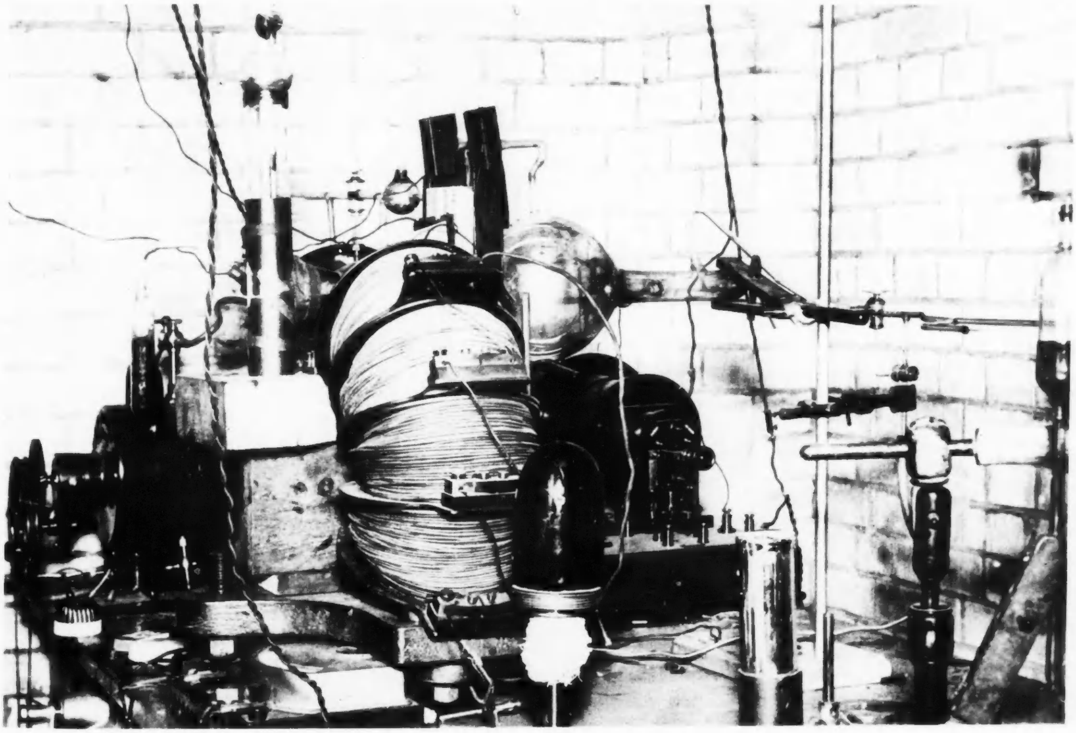

FIG. 5. Positive-ray apparatus in the Cavendish Laboratory. (*Figs. 1 to 5 are from negatives preserved in the Cavendish Laboratory and reproduced with the permission of the Cavendish Professor. Copyright reserved.*)

glass wool or by applying an electric field across it; the first phenomenon pointed towards the agency of particles rather than waves, and the second showed that the particles were probably charged. He also had found that the current that could be passed through the conducting gas was only proportional to the applied potential difference up to a certain point, above this point the gas acted as if its conducting powers were saturated, thus suggesting again that x-rays could only produce a certain limited number of carriers in a given body of gas.

Thomson had already shown that Perrin's experiment of collecting the rays in a Faraday cylinder and proving that they carried a negative charge could be extended. He modified the apparatus, first deflecting the rays by a magnetic field, and showed that the negative charge still took place—again an indication that the charge was being produced by particles affected by a magnetic field rather than by any sort of wave. He had also measured the velocity of propagation of some of the discharges and shown that they were only about 1/2000 that of light. There had been considerable advance in detecting and measuring the magnetic and electric deflection of cathode rays. The rays are notably deflected by even a weak permanent magnet, but Hertz had completely failed to detect any influence by the rays on a suspended magnetised needle, and this was regarded as one of the objections to the corpuscular theory of the rays. A much greater objection was that no electrical deflection of the rays had ever been detected. Thomson set himself to investigate this phenomenon, and the research occupies a central position in the discovery of the electron.

In his first attempt to deflect the rays electrostatically he used a pair of parallel plates producing an electric field through which the rays were shot. No steady deflection was produced when the current was running; but J.J. noticed that there was a slight flicker just as the deflecting current was being switched on and off. He saw that it was likely that the gas in the tube was setting up some sort of electrical barrier, preventing the field from deflecting the beam of cathode rays. To get rid of this impediment he set about the most difficult experimental task of producing a much better vacuum within the tube, removing the considerable quantities of gas condensed on the walls of the tube and on the electrodes. This was done by running the discharge continuously, day after day, and pumping all the time with the best vacuum apparatus then available. Eventually he was able to measure the electrostatic deflection and compare it with magnetic deflections.

As early as 1884, Schuster had been able to deduce from the magnetic deflection alone that if the particles had the charge and mass of hydrogen molecules, their velocity could only be of the order of 1/1000 of the expected magnitude. This was thought be reasonable in view of the many collisions which these particles were thought to have with the molecules of the gas. Thomson was now able to show that the electric deflection indicated the factor of 1/1000 should be associated with the charge and mass of the particles rather than with their velocity, and he was able to check this result by determining calorimetrically the energy carried by the rays. Further experiments with improved cathode rays with better-defined rays and with higher vacuum led him to more accurate quantitative results and he was able to put forward two very striking results of the greatest importance and significance. Firstly, the ratio of the charges to mass (e/m) of the particles was of the order of 10^{-7}, whereas the greatest value previously found was 10^{-4} for the atom of hydrogen in electrolysis: thus either the cathode-ray corpuscles were much lighter than hydrogen atoms or they carried a much greater charge. Secondly, J.J. found that this ratio of e/m was the same whatever gas was used in the tube—the mean value of twenty-six different determinations was $2{\cdot}3 \times 10^{7}$ and this was also shown to be independent of the material used for the electrodes and for the glass bulb of the cathode-ray tube. He went on to confirm the constancy of the value by measuring the ratio found for the carriers liberated by the action of ultra-violet radiation on metals, by hot wires, and by x-rays.

Not only had he found that the ratio of charge to mass was so much greater than for the smallest atoms, but he had also determined the velocity of the rays and found them enormously larger than normal molecular motions. He presented his conclusions at the Royal Institution in London on April 30, 1897, and stated that his results "seem to favour the hypothesis that the carriers of the charges are smaller than hydrogen atoms". At first his views did not make much impression on the scientific world, but although they rapidly gained momentum there could hardly be complete acceptance until separate measurements could be made to determine the charge and the mass of the particles. It was, however, clear that a new type of particle, probably much smaller than the hydrogen atom, had been discovered. Thomson called it a "corpuscle" and continued to use this term for many years, even after the name "electron" had long been accepted by other physicists. Thomson himself had investigated mathematically the properties of such "atoms" of electricity long before his work on cathode rays, and he had reached the conclusion that such a particle, though it contained no ordinary matter, would act as if it possessed a mass depending on its charge and radius. When the discovery of the electron was announced there were some who thought that the minute mass was probably all explicable as due to the charge, but Thomson himself does not seem to have shared this opinion.

At this time C. T. R. Wilson was investigating the process of cloud formation, and especially the nuclei around which condensation took place after the grosser dust particles had been removed from the air. He realised that here there was a technique for studying individual molecules of atoms of some sort that were in an exceptional state which made them act as nuclei for the minute drops in the cloud, and he suspected that these particles might be charged atoms or ions. Wilson tried out x-rays on his own line of research. Again the miracle happened, and a clue was provided which led Thomson towards explaining ionisation by x-rays. Moreover, Wilson was brought to the design of

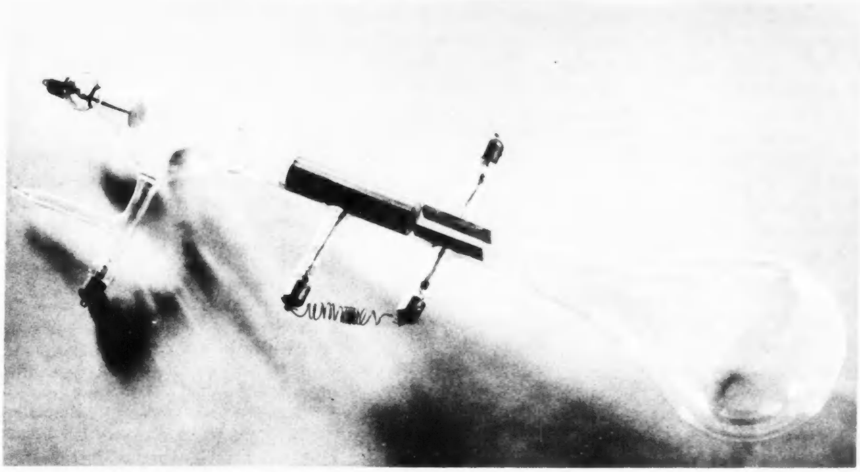

FIG. 6. J. J. Thomson's cathode tube for e/m measurements: now in the possession of the Deutsches Museum, Munich, who have kindly made the photograph available.

apparatus which is now familiar as his Cloud Chamber, an instrument more important than almost any other in the beginnings of atomic physics.

J. S. E. Townsend began an investigation of the subsidence of the clouds caused by condensation. He is responsible for the suggestion that the rate of subsidence could be used to estimate the mass of the droplets, using a calculation of terminal velocity that had been made some time before by Stokes. With the mass of the droplets known, it is a relatively simple matter to determine their charge by applying an electric field. Townsend found a charge of 10^{-19} coulomb, but failed to draw any far-reaching conclusions. Thomson took up the idea, and by measuring directly the current carried by a stream of ionised particles he was able to make a good estimate of the charge on an ion. Having by now measured e/m for particles in cathode rays and those produced by ultra-violet radiation and from an incandescent carbon filament, and also having determined the charge alone for ions produced by x-rays and by ultraviolet radiation, he communicated the research to the British Association at their Dover meeting in 1899, under the title: "On the existence of masses smaller than atoms."

At this time Henri Becquerel discovered radioactivity (1896) and his research was extended by the Curies. Everyone at the Cavendish was anxious to see what effect this would have on their researches. For J.J. it was a new source of ionisation, and he was able to demonstrate that once again the ionisation was being caused by "corpuscles" smaller than atoms and having the same properties as before.

For the next few years Thomson's main work was to consolidate the position by writing his book on the conduction of electricity in gases. This great classic of modern physical writing was published in 1903. A final and expanded version was produced in two volumes (1928–33) by J. J. Thomson and his son, G. P. (now Sir George) Thomson, who had just then demonstrated the wave properties exhibited in electron diffraction. It is one of the most remarkable personal occurrences in physics that a father and son should have worked independently and discovered the contradictory properties, particle, and wave, of the electron.

HONOURS FOR J.J.

In 1905 J.J. was appointed to a Professorship in the Royal Institution (though still retaining his post in Cambridge. In 1906 he received the Nobel Prize, and in 1908 he was knighted. In 1912 he was awarded the Order of Merit.

Having reached an understanding of rays of negative electricity, Thomson now set about similar studies of rays of positively charged particles. Goldstein had found in 1886 that if holes or channels were made in the cathode of a discharge tube, rays streamed through making a luminous track and causing a phosphorescence on the glass bulb rather different from that produced by cathode rays. He called these new rays *canalstrahlen* and showed that they differed also from cathode rays in not being deflected by a magnetic field. In 1898 Wien showed that they were deflected, but only by a powerful field and in a direction indicating that they were positively charged particles created from the residual gas in the tube. Thomson found great technical difficulties in the way of experimental work on these positive rays. If there was insufficient gas in the tube no charged particles could be produced, on the other hand if the pressure was not very low, the discharge could not pass. He solved this difficulty in many stages; first by using a large bulb, then by making the channel very narrow—a hypodermic needle was used at one stage—and evacuating the bulb on one side. The key to successful working was eventually found to be the use of charcoal cooled by liquid air as a means of obtaining the high vacua required. Without such a technique much of Thomson's later work would have been impossible. The laboratory received a timely gift of a liquid air plant, and the facilities it gave made a difference to all work in the Cavendish. Nearly all the models of the positive ray apparatus made by Thomson have been preserved. The first model has a small bulb—far too small for its purpose. The second model rectifies this, the third adds the

charcoal and liquid air technique, and with this Thomson got his first results. Deflecting the rays in one direction by an electric field and at right angles to this by a magnetic field, he found that the rays could be spread out into a series of parabolas, each one corresponding to a stream of charged particles of various velocities but with constant e/m. Assuming that the charges were units or simple multiples of the basic electronic charge (but positive), it was found that the masses corresponded to those of atoms and combinations of atoms in the tube. Subsequent photographic models enabled research to be continued with greater ease and accuracy of measurement.

The most important discovery was the detection of two separate parabolas in the case of the inert gas, Neon, samples of which had been obtained from Dewar, Thomson's colleague at the Royal Institution. These parabolas indicated atomic weights of 20 and 22, showing that neon existed normally as a mixture of these two isotopes—an occurrence which had been suggested previously by Soddy in the case of radioactive elements, but which had not hitherto been observed in stable substances. Thomson was by no means certain of his findings; his apparatus was not sensitive enough to distinguish clearly between atomic weights of 20 and 20·2 (that of natural neon), and the value of 22 could have been due, J.J. thought, to the formation of a transient hydrogen compound, NeH_2. The later work by Aston, who developed the technique further, producing the mass-spectroscope, confirmed also the existence of isotopes, not only in neon but in most other elements as well.

During the First World War the laboratory was turned over entirely to being a workshop for the manufacture of precision gauges, and J.J. became a member of the "Board of Invention and Research" set up by the Government to assist the war effort. In those days the military importance of physics was slight, and the Board proved to be an almost useless waste of professional manpower.

J.J. served as President of the Royal Society from 1915–20; he had already served as Vice-President 1911–13.

Early in February 1918 Thomson was offered the Mastership of Trinity College, Cambridge, perhaps the most valuable of all permanent Cambridge appointments. The gift of it lies with the Crown, not with the College itself.

At first J.J. thought that the Mastership would not hinder his work at the laboratory, though he intended to give up the lectures and his professorial salary. With all the work of getting the laboratory running again it soon became evident that things could not proceed thus, but J.J. was still most anxious to keep contact with the Cavendish and to continue to work there so far as time allowed. The choice of Thomson's most distinguished pupil, Ernest Rutherford, as successor to the Professorship was almost a forgone conclusion, but it required tact and gentle negotiation to settle the question of the relative status and duties of the new Cavendish Professor and the special Honorary Professor, J. J. Thomson. Finally, a room and his old assistants were placed at the disposal of J.J., and all the other research and teaching and the general management of the laboratory devolved on the younger man. Thus the greatest pages of the scientific life of J. J. Thomson came to an end, but he continued in his Mastership of Trinity and as an eminent public figure for more than two decades. His last contribution to the *Proceedings of the Physical Society* was a section of the obituary notice for Lord Rutherford, whose life he had spanned.

IN RETROSPECT

This account has not striven to give details of all the workers in the Cavendish Laboratory and elsewhere in the world who helped to bring about those changes in physics with which the name of Thomson should be associated. It would be invidious to claim that any one man is wholly responsible for even a single step in the advance, but to attempt to cite all the work, even in the Cavendish Laboratory alone, would be to write a complete history of modern physics. The importance of J. J. Thomson is that he exhibited so clearly a whole series of contradictions which appeared in physics during his lifetime. He was an individualist and his mind was "a province unto itself", yet he led a team and created a school around him. He was an experimental genius, yet his work was largely carried out by hands other than his own. Above all he had been educated well within the classical tradition of mathematical physics, and though he was a major participant in the breaking of its bounds he never took kindly to relativity or to quantum theory—accepting them but perhaps not feeling that they were part of the physics with which he was concerned. He opened the door into modern physics, and standing on the threshold, he held it wide for the thirty-four years for which he was Cavendish Professor.

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GRAVITY AND THE OLYMPIC GAMES

J. C. EVANS, B.Sc., Ph.D.

National Physical Laboratory, Teddington, England

Nearly three hundred years ago, Newton—so the story goes—sitting in his garden at Grantham on a late summer afternoon, noticed an apple fall from the tree and, inspired by this simple event, was led to explain the motions of the planets. The theory he then put forward has ever since remained a fundamental concept which is taught daily and universally to all students of the physical sciences. Early in elementary dynamics the parabolic flight of Earth-bound bodies in the Earth's gravitational field is found explicitly expressed by well-known equations. Experts in ballistics who are interested in the trajectories of bullets and shells do not lose sight of these equations; teachers must, of course, remember them; but the practising scientist and the engineer find little use for them, and the student scientist who takes up athletics does not think of extending their use to his hobby. It is not surprising then that no one, apparently, has hitherto discussed the effect of gravity on the performances put up in the Olympic Games.

The author was led to consider the influence of gravity on athletics quite by chance. A British athlete, when Putting the Shot some time ago, had achieved a distance which exceeded the British National record. But the shot, of nominal weight 16 lb., was found to be $\frac{1}{2}$ oz. light, and the question arose, "What effect had this defect in weight on the length of the put?" If certain reasonable assumptions are made, one of the simple equations defining the flight of the shot may be used to calculate the effect, at least to a first order of approximation. One assumes that (1) two shots, one of correct weight and the other light, are projected at the same angle to the horizontal; (2) the athlete provides in each case precisely the same effort; (3) the two shots have the same volume, external form, and surface condition; (4) the influence of air resistance on the trajectory can be ignored.

Then, if V is the velocity of projection, θ the angle of projection measured from the horizontal, and g the acceleration due to gravity, the range S is given by

$$S=\frac{V^2}{g}\sin 2\theta.$$

The first assumption makes θ constant. The second implies equal impulse and therefore equal initial momentum. If, then M and $M-\delta M$ are the masses of the two shots, V and $V+\delta V$ their velocities of projection,

$$MV=(M-\delta M)(V+\delta V)$$

or, to a first approximation

$$\frac{\delta V}{V}=\frac{\delta M}{M}=\frac{\frac{1}{2}\text{ oz.}}{16\text{ lb.}}=\frac{1}{500}.$$

Expressed in logarithmic form, the equation for the range becomes

$$\log S=2\log V+\log\sin 2\theta-\log g$$

and, differentiating this,

$$\frac{\delta S}{S}=\frac{2\delta V}{V}=\frac{2}{500}.$$

Since S is about 55 feet, the reduction in range which would result by changing the light shot for one of correct weight would be about $2\frac{1}{2}$ inches.

Athletes must, of course, use shots, hammers, and javelins which conform to the regulations and the effect on their performances of irregularities in their implements can have only academic interest. What is much more intriguing, when one remembers that gravity varies appreciably over the Earth's surface, is that the expression for the range shows it to be inversely proportional to g.

EFFECTS OF GRAVITY IN MELBOURNE

The 1956 Olympic Games are now being held in Melbourne, Australia. The 1952 Olympics, it will be remembered, were held in Helsinki, Finland. The Earth is an oblate spheroid, its equatorial radius being some 13 miles longer than its polar radius. Melbourne (latitude 38°S) is much nearer the Equator than Helsinki (latitude 61°N) and the difference in gravity at the two cities is 1 part in 500. (Oddly enough, both stadiums happen to be the same height above sea-level.)

Looking back at the equation for the range, it will be seen that, when V and θ are constant.

$$\frac{\delta S}{S}=\frac{\delta g}{g}\text{ (numerically)},$$

so that, for Melbourne and Helsinki,

$$\frac{\delta S}{S}=\frac{1}{500}.$$

If, then, an athlete makes exactly the same effort at Melbourne as he did at Helsinki he can expect, under identical atmospheric conditions, to improve on his performance to the tune of 0·2%. This can have a significant effect on several of the field events. On Putting the Shot (record 57 feet $1\frac{1}{2}$ inches) it will mean an increase of $1\frac{3}{8}$ inches; on Throwing the Discus (record 173 feet) and the Hammer (record 183 feet) it will be about 4 inches; on Throwing the Javelin (record 242 feet) it will be nearly 6 inches. That these increases are not unimportant will be appreciated when it is realised that new records may be won on increments of 1 cm. (0·4 inch). On the other hand, the performances in the High Jump, Long Jump, and Pole Vault will hardly be affected by increases of $\frac{1}{16}$ inch, $\frac{1}{2}$ inch, and $\frac{1}{3}$ inch respectively.

If one considers other cities in which future Olympiads may be held, one sees that at Johannesburg (latitude 26°S) the gravitational acceleration is 1 part in 300 less than that at Helsinki. This is approaching the maximum variation at sea-level on the Earth's surface, namely 1 part in 200.

For many years scientists have had to take account of the variation of g over the Earth's surface when making certain kinds of measurement. The measurement of atmospheric pressure by means of the mercury barometer, for example, is influenced by the local value of gravity, and likewise the absolute measurement of the ampere by weighing the attraction between coils through which current is passed. Similarly in the precise measurement of force by means of dead-weights, change in the value of g as between one locality and another, affects the result. It has therefore been customary to make allowances for the local value of g and, by international agreement, the results obtained in the types of measurement instanced are corrected to a standard value of gravity. This value, 980·665 cm./s.^{2} ($\equiv$32·1741 ft./s.^{2}), was, when first adopted in 1901, thought to be the value of gravity at mean sea-level in latitude 45°, but subsequent determinations showed it to be wide of the mark. Nevertheless, 980·655 cm./s.^{2} has continued to be the accepted standard value, though now stripped of association with level and latitude.

Perhaps, then, one should ask whetner the time has not come for recognition by the responsible authorities of the influence of gravity on athletics. And if it is decided that the performances in different localities should be brought to a common gravity value, it is to be hoped that the standard gravity chosen will be that which already has international sanction in science! In the meantime, should we predict some new records in the field events in the 1956 Olympic Games?* Perhaps; but we should be in no doubt if an Olympiad were one day to be held on the Moon, where g is one-sixth of the value on the Earth, and a javelin throw of 1400 feet would be commonplace.

* At the time of going to press, the Games have not yet begun.—Editor.

SCARAB

DR J. L. CLOUDSLEY-THOMPSON, F.L.S.

Kings College, London

The Egyptian hieroglyph of the sacred scarab represents *Scarabaeus sacer*, a beetle whose habits have been so vividly described by the great French naturalist, J. H. Fabre. This insect acts as a scavenger by breaking up and burying the droppings of cattle and other animals. The female detaches a portion of dung and forms it into a pellet, sometimes as large as a fist, and compacts this by pushing it backwards uphill with her hind legs and allowing it to roll down again. The ball is then rolled away by the beetle, who pushes when necessary with her broad head or walks backwards dragging it with her front legs. Not infrequently she is assisted by a friend, who is usually of the same sex, until a suitable place is reached and the owner commences to excavate a chamber for the reception of her prize. Sometimes the friend takes this opportunity to roll the ball off for her own use; but if no such disappointment occurs the *Scarabaeus* buries it in a subterranean chamber and remains with it until the food is entirely exhausted when a fresh supply is sought.

In the autumn a larger subterranean chamber is formed to which the beetle carries dung until it has accumulated a mass of provender the size of an apple. In this an egg is deposited. In certain other dung-beetles, such as *Copris hispanus*, the male and female combine to excavate a very much larger earthen chamber containing from two to seven ellipsoidal balls of dung, in each of which an egg is laid. These are guarded while the larvae are devouring the food thus provided and when the young beetles emerge they are escorted to the exterior and the little family disperses. The devotion of the parent beetles may well be the origin of the charming Arabic proverb: in the eyes of a mother dung-beetle her young are as the gazelle!

The name "scarab" is derived from the Latin *scarabaeus*, a beetle, but the ancient Egyptian word for beetle is *kheper* which also means "to exist". The divine scarab was "Khepri", the existant who gave life to the sun when that deity was dead and passed through the other world. Then the soul of Khepri was united with that of Ra and eternal existence reanimated the dead. The scarab beetle was therefore sacred to the sun god at Heliopolis whence came the colossal granite scarab now preserved in the British Museum. No doubt the Egyptians identified the sun with the ball of dung from which the young beetles emerged, and were impressed by their sudden appearance after a period of complete absence. Furthermore *Scarabaeus* will sometimes lay its eggs in the body of a dead companion, and this may have engendered the symbolical idea of life coming forth from death. Hence scarab beetles were venerated as the emblem of resurrection and continual existence, and in very early times actual beetles were preserved in prehistoric graves.

Later, however, scarabs fashioned in stone were placed in the bandages of the Egyptian mummies, while larger scarabs engraved with the words of the sixty-fourth chapter of the Book of the Dead were placed on coffins of the New Kingdom. This, the Chapter of the Heart, identified the scarab with the heart of the deceased and conjured it not to betray him in the final judgment before Osiris.

Scarabs with flat bases engraved with designs or the name of the king were used as seals, and hence have great historical value, while forgers of antiques have carried on a brisk trade in scarabs for many years. In the Twelfth Dynasty spiral patterns became common, and

Scarabeus sacer.
Photograph by the author.

from the Eighteenth Dynasty onwards scarabs with inscriptions of spells or the names of gods were used as charms and given to pilgrims to holy places. Amethyst scarabs, and other made of schist or steatite glazed blue or green but with plain bases, were common articles of Middle-Kingdom jewellery and were carried by trade to most of the islands and shores of the eastern Mediterranean and Mesopotamia. The Greeks imitated them in paste, and Etruscan gems of the 5th and 6th centuries B.C. were in the form of scarabs. Except the form, however, there is said to be little in common between the scarabs of Egypt and those of Etruria.

Scarab beetles have frequently been used for medicinal purposes and the ladies of the Nile valley waxed fat on *Scarabaeus sacer*. On the other hand in Tunisia the desert beetles *Blaps* spp. were used for the same purpose despite their disgusting odour. In Egypt and the Levant both *Scarabaeus* and *Blaps* prepared with oil were used as a remedy for earache, the stings of scorpions and for all kinds of skin afflictions. According to Pliny the sight of those who gazed on the green scarab was rendered more piercing: consequently in ancient times the insect was greatly in demand by engravers of precious stones to steady their eyes. Galenus, too, recommended the oil in which these beetles had been boiled as a cure for earache, deafness, and scorpion stings; while certain Arabian doctors applied to the eye minute quantities of scarab blood in cases of weakness or blindness. In our own country in the 17th century Dr T. Moufet, whose daughter Patience is better known as "Little Miss Muffet", wrote in his book "Theatre of Insects" (1634)* that a scarab engraven on an emerald used as an amulet "keeps away likewise the headache, which truly is no small mischief, especially to great drinkers".

* *Insectorum sive minimorum animalium theatrum.*

TWENTY-FIVE YEARS AGO

From DISCOVERY, 1931, December, Volume XII, p. 384

In an article, "The Film in Education", R. Neil Chrystal writes: "The value of the film in education is gradually becoming more widely recognised. . . . Many people look upon the introduction of mechanical methods into scientific education with grave mistrust. This attitude is justifiable, if the method is to be used as the sole means to the end in view. Scientific work . . . demands as its foundation practical work on the living organism in the laboratory, coupled with field studies. . . . Laboratory work must, however, be expanded by the use of textbooks, diagrams, and lantern slides, and it is precisely at this point . . . that the film of the future is destined to play an important part. . . .

"The production of scientific films has not so far been taken up by any university or similar institution in this country. A start has been made in the U.S.A., and some day we hope scientific films will be made under the direction of universities as a definite part of their activities. This would surely lead to further experiments in the production of more detailed film studies. . . .

"As to its value in the furtherance of scientific research, the cinema is a new technique in science, the scope and possibilities of which are at present almost untried."

The scope and possibilities still remain "almost untried" after a lapse of twenty-five years. See the "Progress of Science" note in our July issue, p. 265, and correspondence on p. 442 of the October issue.

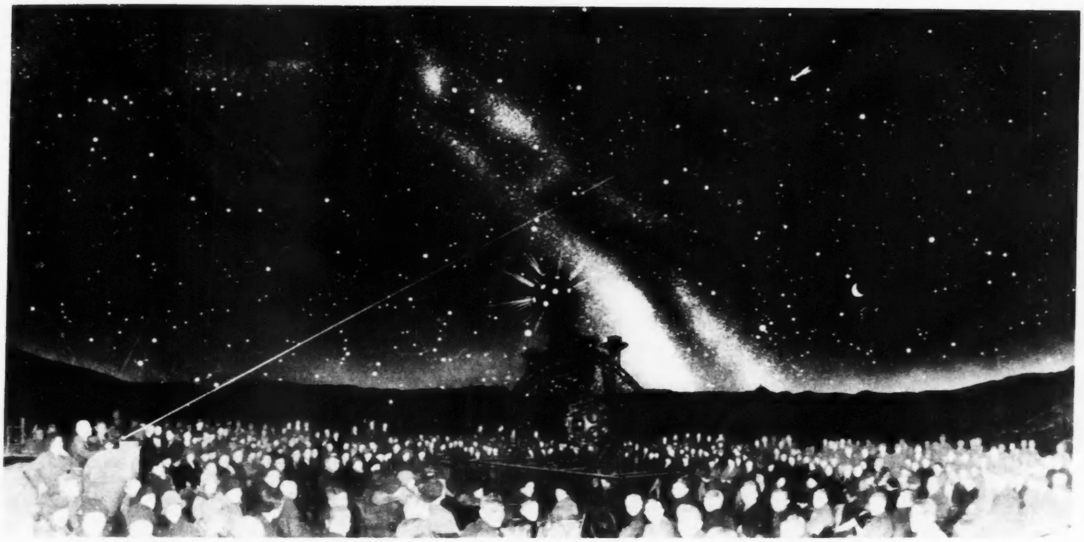

FIG. 1. The artificial night sky of the Zeiss Planetarium. The lecturer is using the luminous pointer to indicate the position of Corona Borealis.

A PLANETARIUM FOR LONDON

FRANK W. COUSINS, A.M.I.E.E., A.C.I.P.A., F.R.A.S.

The first planetarium was opened in Jena, Germany, on the roof of the Carl Zeiss factory in 1923. Twelve planetaria were set up in Germany and Austria between 1925 and 1928. Rome had one in 1928, and Moscow in 1929. The first American planetarium was built in Chicago and opened to the public in 1930, and before 1949 five others were built in various American cities. By 1939 twenty-seven planetaria were in existence in all parts of the world, among them those in the Hague, Stockholm, Milan, Osaka, Tokio, Paris, and Sao Paulo. The London Planetarium will be approximately the thirty-fifth in the world.

The Science Museum of South Kensington in London has been aware of the need for a planetarium in England, but no decision on its plans has ever been made public. During the Festival of Britain in 1951 the scientific staff planned to erect a planetarium on the Festival site, but shortage of time and lack of space prevented fulfilment of the project. Madame Tussauds Ltd., in Marylebone Road, London, ordered a planetarium some time ago, and at the beginning of February started to build the hemispherical projection theatre for it. The article here published is therefore most relevant, and we hope it will arouse readers' interest in the astronomical phenomena which they will be able to see when the planetarium is completed, probably in the autumn of 1957.

Madame Tussauds' planetarium will occupy the site of their bombed cinema next to the famous Waxworks in the Marylebone Road, London. Messrs. Carl Zeiss of Oberkochen in Western Germany are constructing the £50,000 optical projector, on which work is now well advanced.

THE ZEISS PROJECTOR

The modern Zeiss projector is a development of an idea conceived by the German inventor and engineer, Dr W. Bauersfeld. A prototype planetarium containing a fixed-latitude projector was erected on the roof of the Carl Zeiss factory at Jena in 1923. The main projector comprised a powerful source of illumination directed by a multiplicity of condensers to produce star images, and a cage, housing orrery mechanisms, for moving projectors to throw images of the Sun, Moon, and five naked-eye planets. All the images were accurately thrown upon the inside of a hemispherical dome, and the observer within the dome received an impression of being under a cloud-free sky, the stars having a brilliance as seen from a high altitude observatory such as the Pic du Midi.

From this beginning, and encouraged by the fact that 80,000 persons came to see the roof planetarium in the first eighteen months, Zeiss directed their attention to designing a projector which would be able to produce an artificial sky as seen from any latitude. The solution of the problem resulted in the now well-known dumb-bell form of projector. Fig. 1 presents the modern projector in operation and shows the artificial sky it is capable of producing. It will be seen that the stars, the Moon, and the planets appear as in nature; the instructor is using his light-pointer to pick out the well-known star group Corona Borealis.

The modern dumb-bell projector is usually placed at the centre of a hemispherical dome of approximately 80 feet in diameter. Two techniques for dome construction have been favoured, one of stretched white linen over a metal network, the other painted steel or

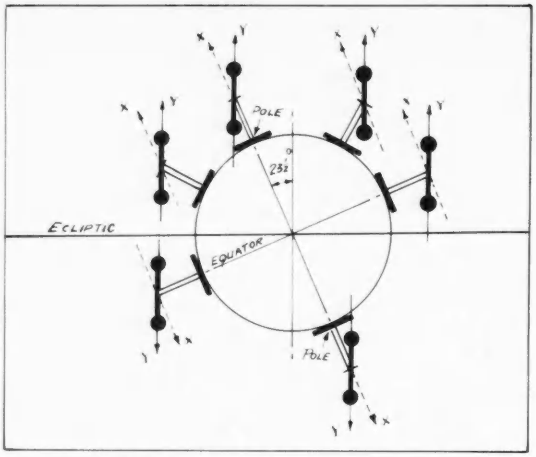

FIG. 2. Diagram showing how the projector can be orientated for different latitudes.

aluminium plates. In the latter construction the plates are perforated with small holes of 1/16 inch diameter to improve the acoustics. A cut-out of steel is arranged to represent the actual skyline of the locality at which the planetarium is situated. A desk is provided for the lecturer from which to control the projector and its auxiliary equipment (Fig. 9).

Details of the projector are shown in Fig. 6 and may be identified from the key. The photographs of the projector, Figs. 7 and 7*a*, may be compared with Fig. 6. The main projector structure, containing all the minor projectors, is so mounted that it may turn independently about any one of three axes. First, it may turn about an axis Pn Ps parallel to the polar axis of the Earth. When this motion is used without other motions, the effect naturally is to transport the images across the dome sky in exactly the same way that the diurnal rotation of the Earth on its axis causes the apparent motion of the stars and planets across the sky in just under twenty-four hours.

Second, the machine may rotate about an axis Qn Qs perpendicular to the plane in which the Earth moves about the Sun. Without the other motions in use, the effect of this is to swing the north pole of the sky around the circle which it makes each 25,800 years, because of the precessional "wobbling" of the Earth's axis. The axis of this precessional motion of the instrument intersects the daily-motion axis at the centre of the room.

Third, through this same intersection runs the axis EW for the remaining motion of the machine, a horizontal one from the east to the west point. Rotation about it transports the images on the dome as though the viewer of the skies were travelling along a meridian of the Earth from pole to pole. The orientation of the projector for different latitudes is seen in Fig. 2.

Each star globe contains a powerful source of illumination and sixteen aspherical condenser lenses (Fig. 5). The star images are provided by perforated copper foils punched by hand. The perforations are graded to provide star images of diameters from 1/16 inch to 2 inches. On the hemispherical dome this provides a star pattern in which the diverse star magnitudes of the real sky are faithfully simulated. In actual experience the stars of the night sky are true points of light, but the star discs seen on the hemispherical dome are not objectionable unless the observer is remote from the centre of the dome. A clever occulting device, gravity-controlled, causes the light projected for the star images to be reduced as the star images approach the artificial horizon, thereby producing the illusion of increased atmospheric absorption.

Certain well-known variable stars need special projectors to show the variations in light output of the variable and to simulate the periodic increase and decrease in stellar magnitude. Diffuse objects such as nebulae and globular clusters are also projected on to the planetarium sky from specially designed projectors to give a faithful reproduction of their characteristic appearance.

The Milky Way (the edge of our Galaxy) requires special treatment, and this is provided by a drum-type projector on each star globe containing an accurately stippled film strip to produce the characteristic pattern of the Milky Way as seen in the Northern and Southern hemispheres. The occulting of the Milky Way below the horizon is effected by partly filling the drums with a quantity of mercury.

The names of the well-known constellations (Fig. 8) may be thrown on to the artificial sky, and eighty-eight names may be projected at one time so that the sky takes on the appearance of a giant star map from a reference atlas. To facilitate a study of positional astronomy the main reference grids may also be projected so that the Ecliptic, Equator, Hour circles, Parallels, and the Meridian complete a fully representative celestial sphere.

The main cage of the central portion of the dumb-bell carries sets of twin projectors for the Sun, the Moon, and the naked-eye planets. The twin projectors are of large aperture so that the struts of the cage do not produce serious obscuration of the projected light. The Sun cage comprises a simple orrery mechanism. The Sun is represented by a central pivot and an Earth

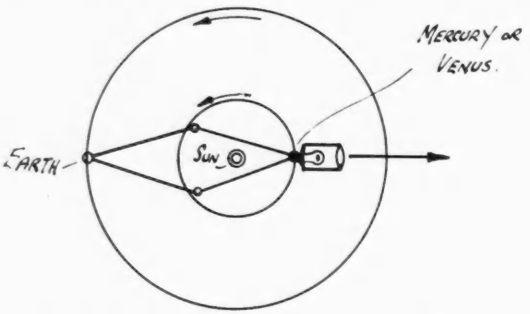

FIG. 3. Diagram showing the linkage for an inferior planet.

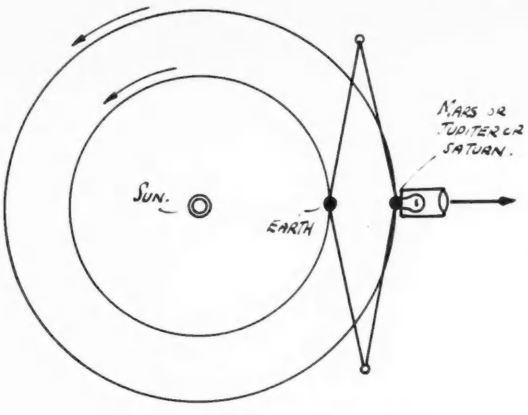

FIG. 4. The linkage for a superior planet.

pivot revolves about it. The Sun projector is coupled to the Earth pivot and the Sun pivot by a linkage. The Sun projector points from the Earth to the Sun; consequently the image of the Sun on the planetarium sky moves from West to East through the stars as it should in the course of the Earth's annual journey. Other projectors in the Sun cage provide the Zodiacal Light, the Aureole, and the Gegenschein.

In the Moon cage (Fig. 10) the orrery mechanism is complex. A fixed Earth point and a moving Moon point are so coupled that the Moon moves correctly on the planetarium sky. The mechanism takes cognisance of the regression of the nodes in 18·6 years, and a cup adapted to rotate in one planetarium synodic month provides a mechanism for producing a Moon image with a continuously changing terminator, thereby demonstrating the phase phenomena.

The naked-eye planets Mercury, Venus, Mars, Jupiter, and Saturn each have projectors comprising an ingenious orrery mechanism with a fixed Sun pin (Fig. 11). A set of gears accurately calculated moves a point representing the Earth, and a second set of gears moves a point corresponding to the planet. A linkage carries the projector, and the accurately driven points impart a motion to the linkage in such a way that the motion of the image of the planet is correctly presented on the celestial sphere. The planet orbits in nature are elliptical, not circular, and this is achieved in the instrument by offsetting the gear centres so that the Earth's motion, the Planet's motion, and the position of the Sun do not coincide. The inclination of the planet's orbit to the ecliptic is provided by inclining the planet gear. The projectors are all tilted at specific angles to allow for the distance of the planet projector from the centre of the dumb-bell. The linkages for an inferior and a superior planet are shown in Figs. 3 and 4. All the highly complex motions of the naked-eye planets may be demonstrated by these accurate and ingenious orrery mechanisms including the change from direct to retrograde motion and vice versa combined with variation in latitude to produce the loops of retrogression.

DEMONSTRATING THE HEAVENS

The Zeiss projector is extremely versatile, enabling a skilled operator to demonstrate not only planetary phenomena as mentioned above but other celestial phenomena associated with the stellar universe and the anomalies of the Earth/Moon system. The precession of the equinoxes, the diurnal motion and the apparent path of the Sun against the stars may be shown in a matter of minutes. The difficulties of explaining cosmic phenomena are notorious and few people understand them with clarity; while recourse to nature necessitates assiduous observation of the night sky over a protracted period. With such an instrument, however, a large audience may be instructed in basic astronomy in one lecture of short duration on a sky having all the appearance of reality. The accuracy of the instrument is such that it may be used as an eclipse predictor and the operator may show the night sky as it was in the remote past or as it will be in the future. The sky as seen at the antipodes, the poles, the equator, or any intermediate position on the Earth's surface presents no difficulty. Sitting in a comfortable seat one may view the night sky as seen by the traveller as he moves from one parallel of latitude to the next. In the northern hemisphere one may sit and enjoy the beauties of the Magellanic Clouds, Canopus, and the Southern Cross.

Reports from American planetaria suggest that many pieces of ancillary equipment may be added to the main projector to permit the demonstration of astronomical phenomena of value. For example, a projector may be added to show partial, annular, and total eclipses of the Sun complete with Bailey's Beads and the beauty of the corona. Few people are ever privileged to see the breathtaking beauty of a solar eclipse, and this equipment may well be incorporated in the projector being constructed in London. Other accessories used in America enable thunderstorms, lightning, and cloud formations to be demonstrated to the student of meteorology.

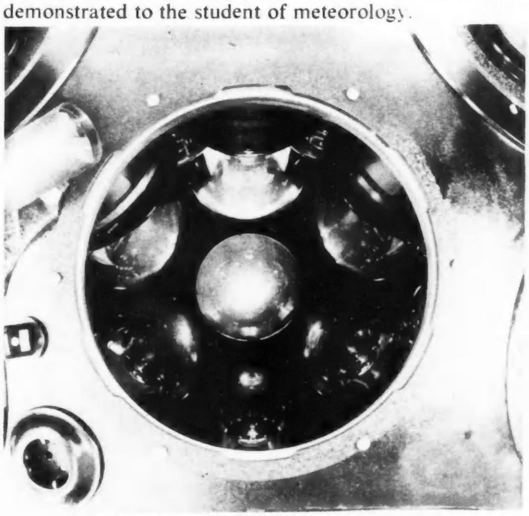

FIG. 5. Inside the fixed-star sphere, with the collimator lenses of the Zeiss Planetarium projector.

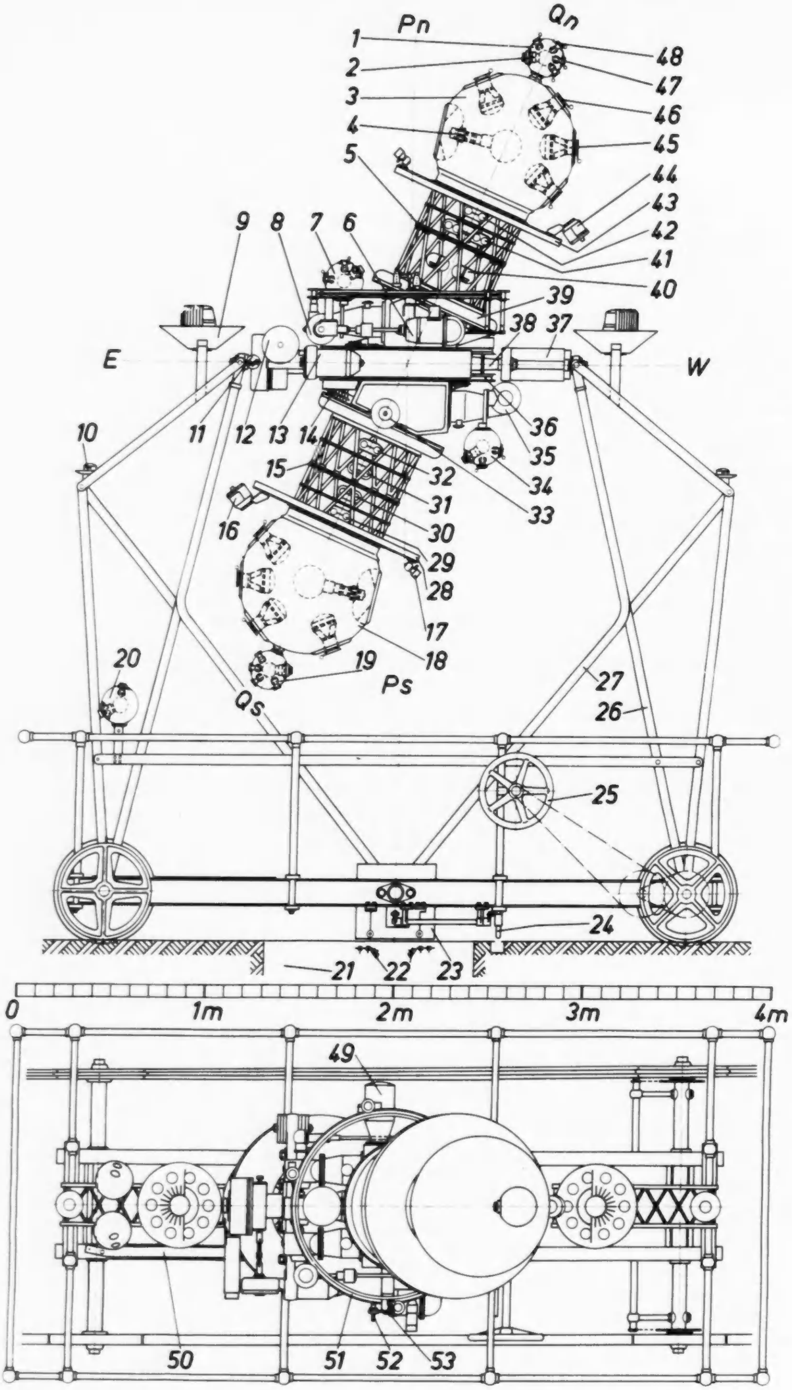

FIG. 6. Diagram of the latest design of Zeiss Projector.

The main optical and mechanical parts (numbers in parentheses) are as follows:

(*a*) Two fixed star globes (3 and 18) with 16 projectors (45) each, 16 mechanical shutters (46) each, one 1000-watt lamp (4) each;

(*b*) Two globes (1 and 19) for constellation names and precession dial with 15 projectors (47) each, 15 mechanical shutters (48) each;

(*c*) Two planetary frameworks (5 and 15) with double projectors and mechanisms for Saturn (42), Sun with aureole (41), Moon (40), Mercury (32), Venus (31), Mars (30), Jupiter (29);

(*d*) Centre piece on cradle (38) with 2 motors for diurnal movement (35), 3 motors for annual movement (8), 1 motor for precision movement (49), 1 motor for polar altitude variation (13), 2 globes (7 and 34) with 6 projectors each—for equatorial grid reference system and ecliptic as well as for the two pole arrows, projector for year counter (6), mechanical precession counter (33), optical polar altitude reader (11), equipment for demonstrating the mean sun and the nautical triangle consisting of lattice ring (51), vertical circle projector (52), hour circle projector (53);

(*e*) Two ruffs (28 and 43)—an important innovation—between fixed-star sphere and planetary framework with 45 special projectors (17) for the 42 brightest fixed stars and the 3 variable stars Algol, Mira, Delta Cephei, as well as the two Milky Way projectors (16 and 44);

(*f*) Carriage frame (26) with 2 spheres with 2 projectors each for Meridian (20), 2 horizon illuminations for morning and evening twilight (10), 2 dome illuminations providing white and blue light (9).

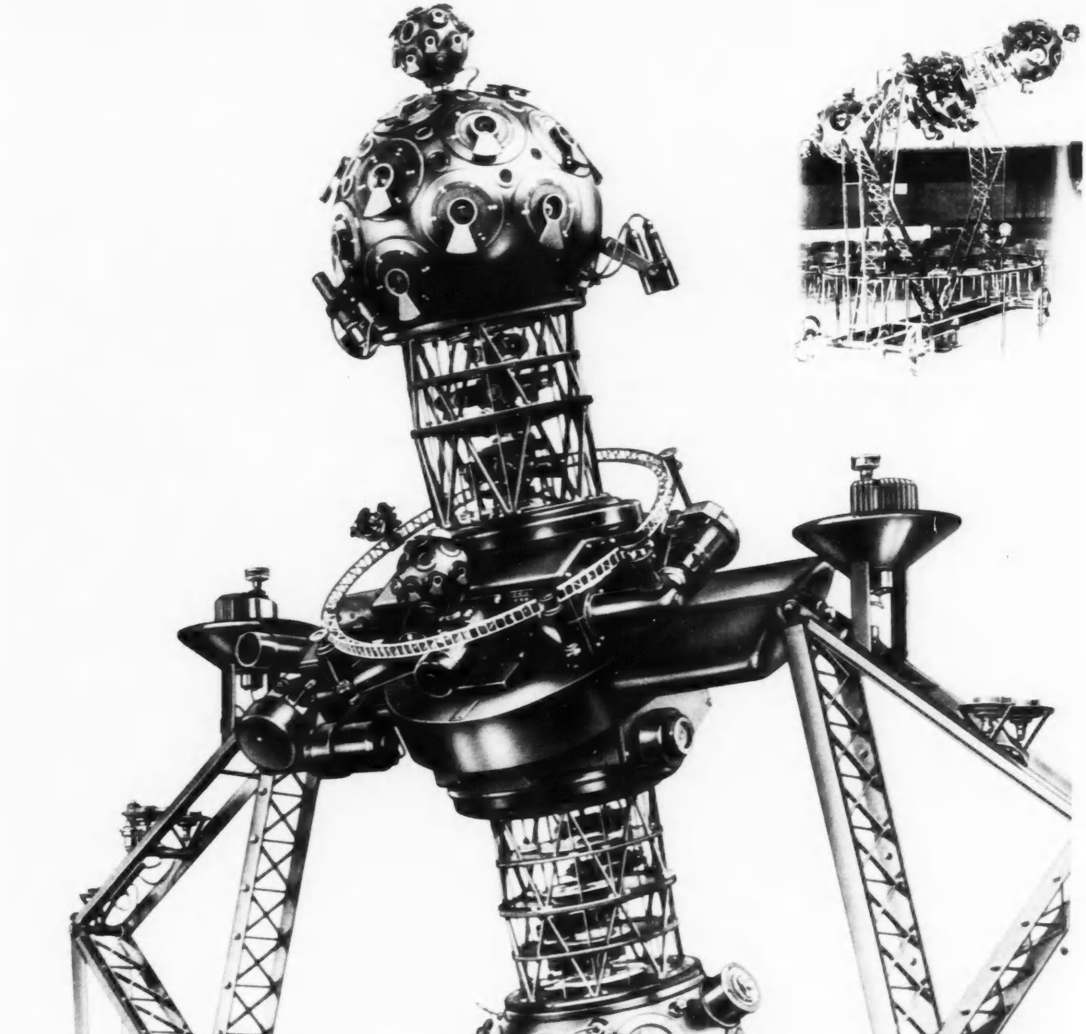

FIG. 7. The Zeiss Projector. (7*a Inset*, the projector tilted towards the horizontal.)

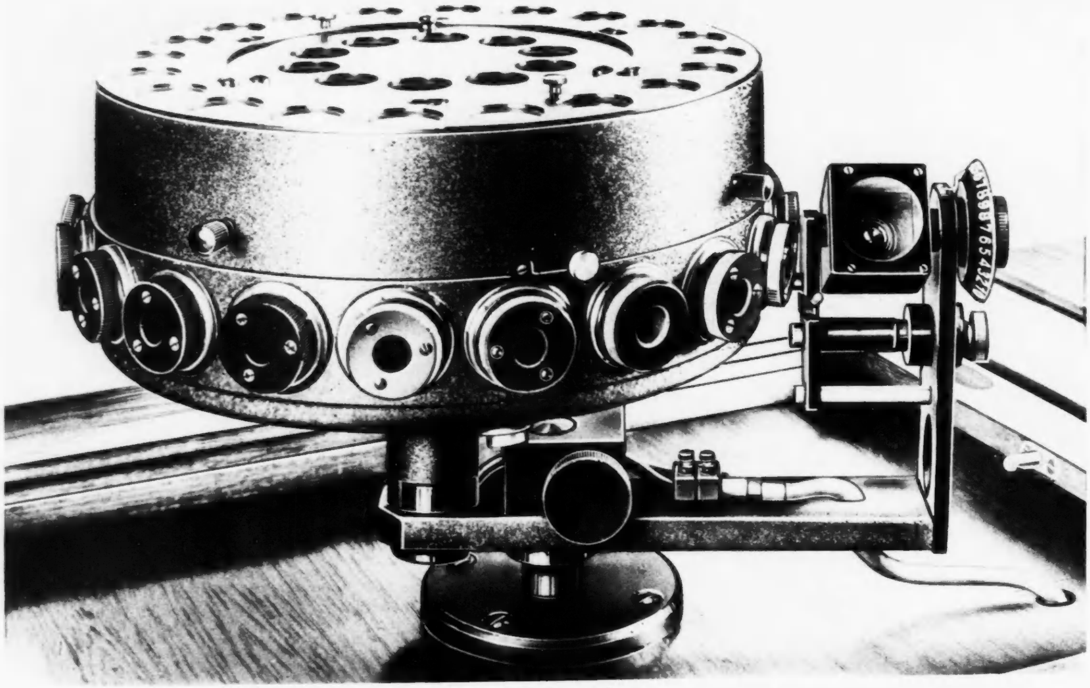

FIG. 8. Constellation projector.

FIG. 9. The modern type of switch- and lecture-desk.

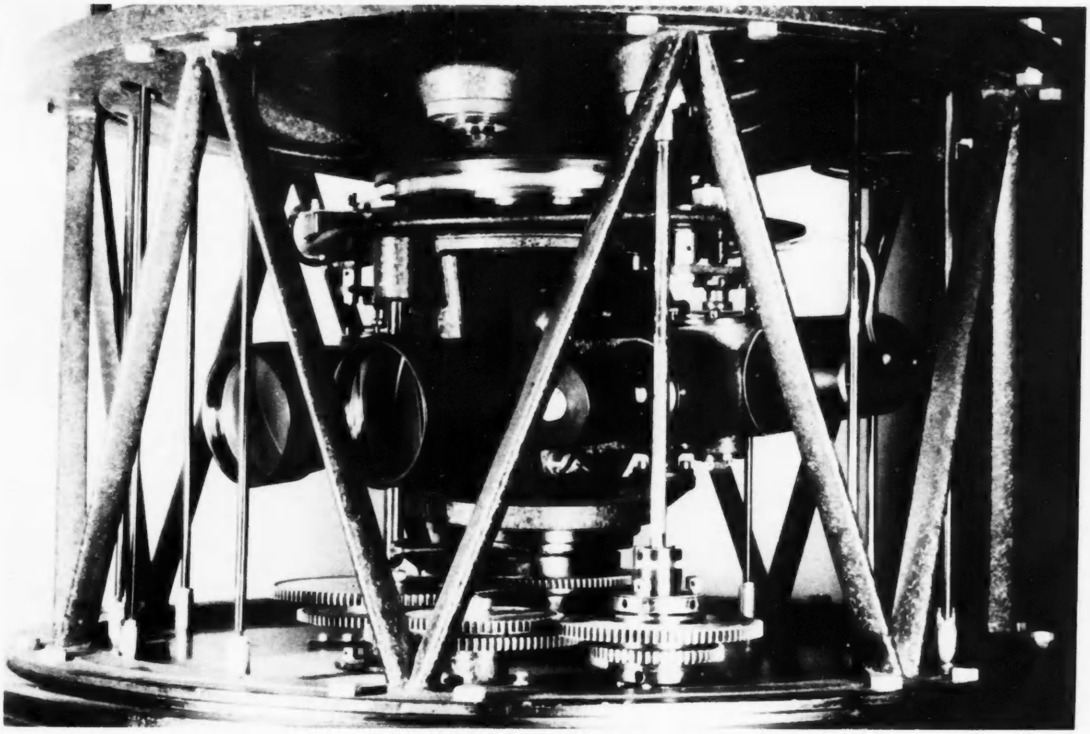

FIG. 10. The projector for the Moon.

Modifications of the Sao Paulo projector by Zeiss have been reported by Dr King, and these are almost certain to be included in the new instrument. The main modifications have been in the star projectors. Previously only Sirius and some variable stars had a special projector; now all stars down to those of the second magnitude are shown by forty-two special projectors and the use of punched copper foil has been superseded by photo-engraved plates. In the Moon projector an aluminised glass mirror of a novel design is used to increase the brightness of the Moon by a factor of four. This enables the markings on the Moon to be shown with a greater degree of accuracy than before. All the lenses in the latest instruments are "bloomed" (treated with *inter alia* magnesium fluoride) to ensure that little light is lost by scattering and internal reflection.

The author expresses his thanks to A. H. Degenhardt, London representative of Carl Zeiss, for the loan of some of the photographs.

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Werner, Helmut, "Die Sterne dürfot Ihr verschwenden" and "Vom Arat-Globus zum Ziessplanetarium". Recently translated into English by A. H. Degenhardt.

British patent: 244448.

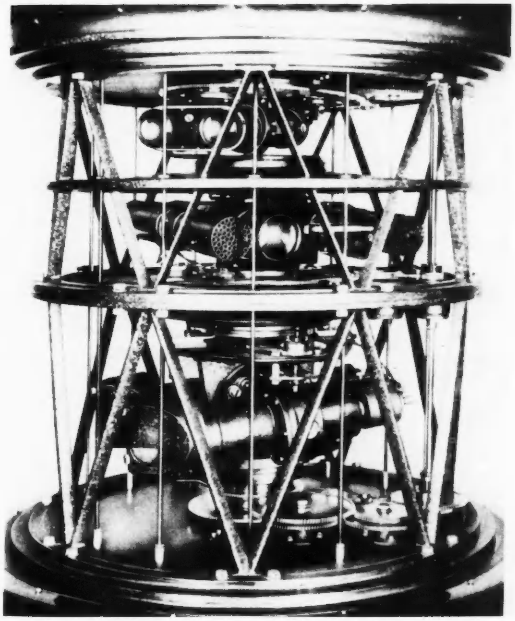


FIG. 11. The planetary framework for Saturn, Sun and Moon. A similar framework embodies the projectors and mechanisms for Mercury, Venus, Mars, and Jupiter.

PROBLEMS OF SOCIOLOGICAL FIELD WORK IN A PASTORAL SOCIETY

DERRICK J. STENNING

Department of Anthropology, University College, London

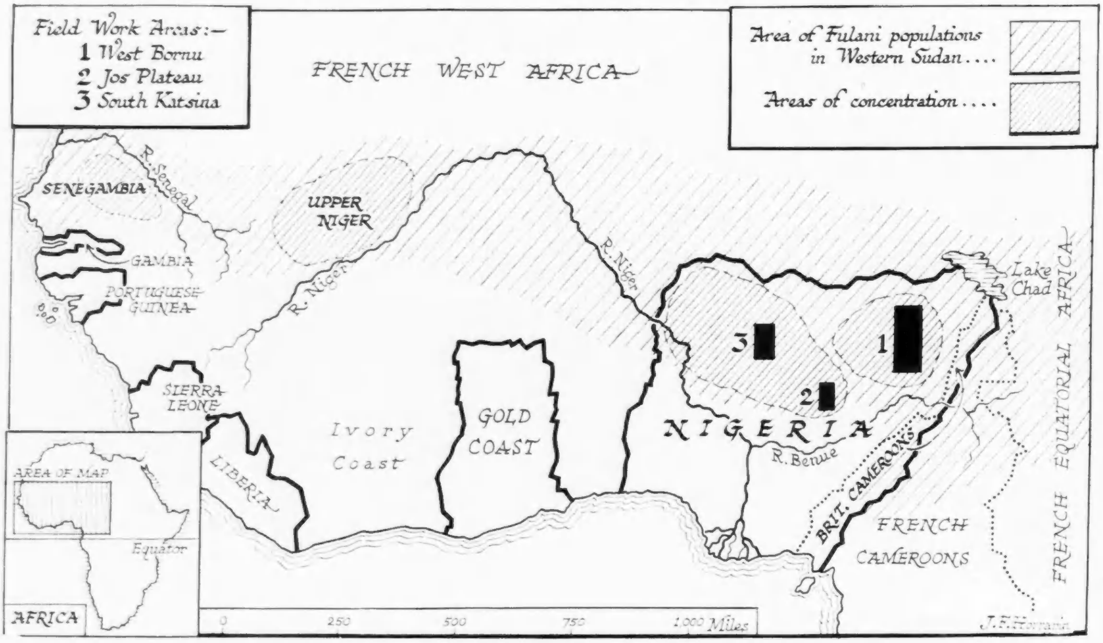
By the canons of modern British social anthropology, sociological field work in a primitive society should be intensive, carried out on a full-time basis for a period of not less than a year; pursued in the vernacular without the aid of interpreters; and aimed at the field worker's individual elucidation of significant correlations between some or all of the major aspects of social life—religious, economic and political institutions, and the social groups which embody them.

THE FULANI OF NORTHERN NIGERIA

From 1951 to 1953 I was engaged in a sociological field study, in these terms, of the Pastoral Fulani of Northern Nigeria. The Fulani are an important African population, numbering perhaps 8 millions, widely distributed in the Western Sudan from Senegambia in the West to French Equatorial Africa in the East, with their main concentrations in Senegambia, Upper Niger, Northern Nigeria, and British and French Cameroons. Of these, the Pastoral Fulani, numbering some 2 millions, depend completely on their herds of cattle for subsistence, and their lives are tuned to continual seasonal movement (transhumance) and periodical migration.

All sociological field studies present two ranges of problems. The first is the problem of sampling. The second is that of observation, communication, and participation. Pastoral societies, and particularly such a population as the Pastoral Fulani, present these problems in a distinctive way.

In all but the smallest and most isolated primitive societies a field study carried out along the lines summarised above involves, consciously or otherwise, some form of sampling. The apparent uniformities of behaviour within a given primitive society give rise to an assumption that the families, cults, chiefs, technological processes and so on observed by the field worker may be treated as representative of the whole culture. Where small island communities in the Pacific, or extremely isolated communities elsewhere are concerned, this assumption is defensible. In Africa, with its large kingdoms, shifting populations, continuous impingements of one society upon another and of European influences upon all, it cannot be. Indeed, local differences in institutional forms assume the greatest importance. The case of the Pastoral Fulani may be regarded as an extreme one, for with their transhumant and migratory life, elements of this population are found in a variety of social, political, economic, and ecological situations. Therefore no intensive study of Pastoral Fulani can lay claim to being representative of Pastoral Fulani populations as a whole, or even of those found in Northern Nigeria. The selection and documentation of these situations is of the greatest importance



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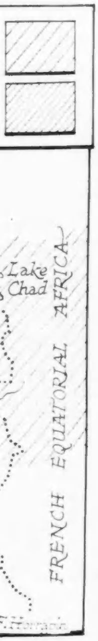


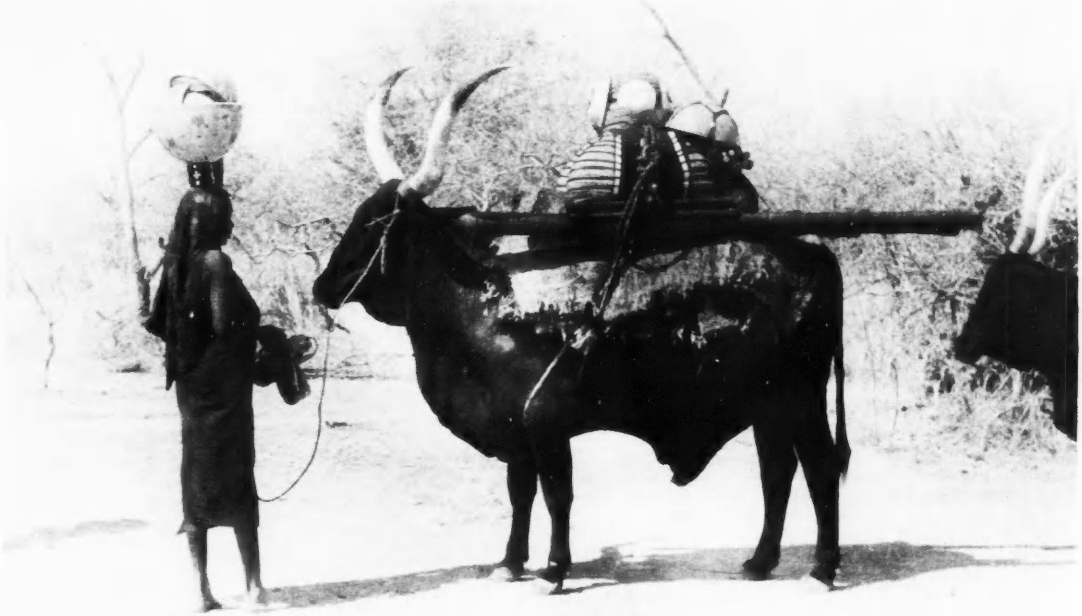


FIG. 1. A Pastoral Fulani housewife moving her belongings from one camp site to another in West Bornu. The long poles form the sides of her bed, and the cross pieces are bundled at the sides and rear of the load. She carries her working calabashes on her head. Those carried on the pack ox are given at her marriage and are never used but only displayed at feasts.

FIG. 2. Pastoral Fulani women drawing water for domestic use from one of the shallow water holes used in the dry season.

for comparative purposes. Three areas were chosen for field work, on the basis of historical, geographical, and social differences. The main study was carried out in Bornu, and lasted more than a year so that a complete seasonal cycle of pastoral activities could be lived through and studied. This is a typical dry savanna area, with a low sedentary population density, in which pastoral movement is unimpeded. Subsequent studies of shorter duration were carried out in Pankshin and Katsina. Pankshin is a highland area in north-central Nigeria, where the absence of tsetse fly and a good rainfall have recently led to a considerable immigration of Pastoral Fulani. Here, they compete and co-operate with the indigenous sedentary tribes in the use of land. Katsina is a savanna area, but one which supports a high density of sedentary population. The Pastoral Fulani here have a close co-operative relationship with the agriculturalists, on to whose land they move after the harvest in the course of their seasonal movements of cattle.

PROBLEMS OF SAMPLING AND SOCIAL GROUPING

This section of areas for study is a form of sampling designed to render the most significant comparative material. In another form the sampling problem had to be extended into field work itself. Every society is made up of social groups which perform specific social functions—families, trade unions, clans, clubs, regiments, congregations, and so on. In Western society there are many and diverse forms of social grouping. In primitive society there are fewer, and the relation between them is more direct. It is a prime task of the field sociologist in a primitive society to enumerate and define these forms of social grouping, describe their functions, and analyse the relations between them. The most important Pastoral Fulani groupings are the tribe, the chieftaincy, the clan, the lineage, and the family. A most practical problem, and one which also has considerable theoretical importance, is to decide how many social groups should be observed, and in what detail. The existence of certain types of social grouping may be readily apparent quite early, but the selection of the most suitable of these groups for study is likely to be a matter of trial and error, or to arise in quite fortuitous circumstances. Nevertheless, in a field inquiry of this sort it is a basic rule that at least one of each type be isolated for as intensive study as possible. For example, in West Bornu, where there are four tribal groupings represented, I concentrated on one tribe, numbering about ten thousand persons. Within this tribe were some ten clans; in two of these I sought detailed genealogical information. Members of these two clans owed political allegiance at four village chieftaincies, of which I was able to analyse only one in any detail. This involved seven lineage groups, of which I concentrated on two. These two lineage groups were made up of ten and fifteen families each, and numbered sixty and ninety persons each. I was acquainted with all the families in each lineage, but lived, of course, in only one family in each.

This brings me to the second set of problems: those of observation, communication, and participation. Each of the forms of social grouping has its own appropriate and distinctive activity. The field worker must observe these activities, be they the complicated ceremonies carried out by an assembled clan, or the prosaic tasks which unfold in the daily life of a family. He must have informants who will give their own descriptions and explanations of them in their own tongue, and will answer questions or volunteer information on the structure of the groups concerned. In some degree the field worker also participates in these activities.

OBSERVATION

In sedentary societies, the practical task of being on the spot to observe is a relatively simple one. In a pastoral society, such as that of the Fulani, special problems arise; social life is governed more stringently by the ebb and flow of the seasons, as they affect the maintenance of herds of cattle. In the wet season, ample water and pasture permit a concentration of cattle and of the humans who depend upon them. Large camps, consisting of from a hundred to five hundred souls are formed, either remaining stationary for the two or three months of the rains, or moving in a body over short distances. The wet season is a time of concentrated ritual and ceremonial activity, based on the concentration of humans, the relative ease of herding at this time, and on the availability of milk surpluses which provide the feast foods. Puberty ceremonies are carried out; betrothals are contracted and solemnised; the various stages of induction into married life are enacted; communal cattle fertility rites are performed; allegiance to chiefs and leaders is demonstrated; fealty to Emirs, and the commitments of the community to the British Administration are embodied in the assessment and remittance of cattle tax. For the field worker, as for the Pastoral Fulani, this is a time of intense and rewarding activity. Hardly a day passes without attendance at some gathering which symbolises in dramatic form a social relationship which is otherwise latent.

But as the wet season closes, and shortages of pasture and water become evident, these concentrations begin to disperse southwards in different directions and at different speeds and impetus. Finally, when the dry season is at its height, the maximum degree of dispersal is attained, and single families may be found wandering between convenient pastures and wells at anything between fifty and two hundred miles south of the scene of their wet season celebrations, and from five to twenty miles away from their nearest kinsmen. The preoccupation of the herdowner is now to move his cattle to the scene of least competition for pasture, water, and the markets where milk is sold. The task of the field worker is to chart and explain these movements. For him the daily round of a single family is important but, in the event, repetitious and even boring. Of much more interest is the comparison of courses taken by a number of families, the relations maintained between these families, and the transactions and mutual interests pursued between the Fulani and their sedentary hosts.

Rather than stay in a single household, the field worker tries to move about in the area covered by dispersed households, in order to arrive at a general picture of dry-season conditions. This involves maintaining an intelligence service equal if not superior to that of the Fulani, who may maintain only intermittent contact with their kinsmen.

In order to maintain maximum mobility in the dry season in areas where motor transport was impossible, I used a pack ox for carrying the few supplies I needed, travelled on horseback, and took a spare horse for the servant who was not in charge of the ox. In this way I was able to cover twenty-five miles a day if necessary, in order to reach households I had known as parts of large wet-season camps. My movements would have been aimless, based on rumour and supposition, if I had not maintained an intelligence service analogous to that of the Pastoral Fulani themselves. Each herdowner is concerned in the dry season to deploy his cattle most effectively in areas where pasture and water is available and where disease is not likely to be encountered. He entrusts the daily herding of his cattle to his sons, but he himself frequents nearby markets at which his womenfolk sell milk. Here he meets other herdowners, and in long conversations the pastoral potentialities of the area are assessed. I joined these groups and plotted the whereabouts of Pastoral Fulani groups in which I was interested. This technique by no means gave a clear picture of the total area in which my selected groups were dispersed. I was able to survey a wider scene by engaging an itinerant seller of kola nuts (a popular stimulant). His trade took him from market to market, as they were held on different days of the week, and his path intersected my own from time to time, by arrangement. He was a clansman of many of the household heads in whom I was interested, and was acquainted on a basis of tribal membership with many more. His reports not only helped me to plot the distribution of Pastoral Fulani, but ensured that I was invited to such limited gatherings (such as namegiving feasts, and funerals) as occur in the dry season. To such observations as I was able to make under dry-season conditions, I added these observations by proxy.

COMMUNICATION

Then there was the problem of communication. Informants were necessary, and men and women had to be selected who might be expected to speak at length on certain topics. Nearly every man in Pastoral Fulani society is a husband, father, and herdowner. Every man is a member of a lineage, chieftaincy, clan, and tribe. But not every man can speak with authority on the traditions of a clan, or the history of the relationship of the tribe with the kingdom in which it may find itself, or the characteristics of a certain tract of country. Early in the study, my selection of informants and topics was somewhat random, but it soon became apparent that for each topic that arose, there was an informant or group of informants regarded as authoritative; there is a term in the Fulani language for "one who has authority to speak". There was of course the possibility that information could be concealed by

FIG. 3. Marketing is an essential part of Pastoral Fulani ceremonies. It is late afternoon in a small, dry-season market in Bornu. The Fulani women have sold the milk in their decorated calabashes and bought yams and pumpkins, as well as new, undecorated calabashes.

directing me to an informant who was not in fact regarded as an authority. These concealments are in themselves of considerable sociological importance. The field worker looks not only for the truth, but for patterns of prevarication.

This channelling of communication by informants can bedevil field work, until the social usages which lie beyond it are discovered. An important early field task was to make sample censuses, by households, of Pastoral Fulani camps; and to take genealogies. Apart from the useful quantitative material afforded by these techniques, the anthropologist also expects to get the names of individuals among whom he may later spend much of his time. In our own society, the use of Christian names, surnames, and nicknames in address or description is governed by conventions the purpose of which we all apprehend. This is true also of Pastoral Fulani, but the conventions are different, and the process of labelling individuals far from straightforward.

NAMEGIVING

Every Pastoral Fulani has at least two names. Seven days after birth there is a namegiving at which a newborn child receives one of the names of Arabic derivation common throughout the Islamic world. In infancy, Pastoral Fulani are given a Fulani name by their grandparents if these are alive, and this name generally suggests the character or comportment of the child, or some outstanding event occurring in its infancy. Later in life, a Pastoral Fulani may acquire a nickname, or may adopt a name. Each of these names is used by different circles of kin or associates, and on different occasions. For example, I can call people reckoned to be of my own generation by their personal names. But husbands and wives do not describe or address each other, or each other's parents by their personal names. People of a senior generation are in general not addressed or described by personal names, except one's

father, unless one is the eldest son. All people of a younger generation may be addressed or described by name except sister's children, or my wife's brother's children. Grandparents and grandchildren may be addressed by personal names. These are merely a few examples from a wide range of naming prohibitions. Persons who may not be addressed or described by name are addressed, for example, "o my brother's wife" and described in various forms of "that woman". In addition to these prohibitions we find that any nameable kinsman who bears the name of an unnameable one, himself becomes unnameable. Persons with the same grandparents' name are conceived to have a certain personal affinity; they are expected to exchange gifts on feast days, and to help each other in trouble.

This mosaic of name prohibitions is connected not only with the Pastoral Fulani notion of personality; but goes with other forms of conduct to stress the quality of social relations—of equality, respect, deference, or prudery—which obtain in the daily regulation of life in the household and camp. Obviously, neither the rules of name prohibitions, nor the social relations to which they referred were known to me at this early stage. I was concerned, somewhat naïvely, with enumerating and identifying a certain number of individuals among whom much of my time was to be spent, and their relationships to each other. My notebooks became filled with terms meaning "her", "that one", "the old woman", and so on. Three names might refer to one individual whom I had confidently taken to be three persons. When the aim of my genealogies and censuses began to be appreciated by Pastoral Fulani, they fell into a convenient way of helping me over my difficulties. Instead of leaving one person to accompany me, they detailed three or four. When one person became embarrassed, or took to inventing names, I could turn to his companions, to one of whom the prohibition would not apply.

This difficulty in identifying individuals by name does not arise only when an anthropologist works among the Pastoral Fulani. They experience it themselves. Much of the conversation between Pastoral Fulani about others is taken up with making clear the identity of the subject without actually using the name. Events associated with the person are quoted (and there are often long side-disputes about these); riddles, puns, and rhymes are used to bring one interlocutor closer to the subject of the conversation. Frequently the original issue is lost sight of. But in the art of conversation, as in the conduct of their nomadic life, the Fulani would agree that it is better to travel than to arrive. As I learned more of the language, took up my place in the camps, and was given a kinship status, however incomplete, I tried to fall in with the spirits of these prohibitions, and refused to mention by name certain neighbours. I thus involved myself in long catch-as-catch-can discussions, much to the delight of my informants. I invented nicknames, some of which were gravely put into general use. But beyond these excursions in etiquette and the art of conversation, I learned to appreciate, even in a fragmentary way, some of the social forces which regulate face-to-face behaviour in the everyday life of the camps.

PARTICIPATION

Thus to the last problem: participation. This may be active, for example, in watering cattle, or moving camp; or passive, as in watching the installation of a chief or the performance of a naming ceremony. In any case the field worker is given a rôle to fill on every occasion, and these rôles are decided more often than not by the people themselves. My most appropriate general rôle was that of a minor chief; this included other rôles such as husband, householder, cattle owner, and nomad. In general this rôle was satisfactory. Sometimes it limited my observation and communication, for example, in the formal and informal affairs of the young unmarried men and women. Sometimes it had to be set aside, by myself or the people, in favour of another. For example, I found it convenient in the early stages to have myself regarded as a child, to whom things had to be taught, and I was treated rather as a son by some informants. On other occasions where broader political issues were discussed, my acquaintances found it difficult to see me in other than roughly my true rôle—that of a semi-official, sympathetic, but somewhat detached European observer. On all occasions, certain behaviour on my part or on that of the people indicated the rôle I or they were to play. I entered into a close relationship with the Fulani head of the village where I made my base. We exchanged gifts and services, and spent long hours talking. On every occasion on which he came to see me, he made his rôle clear by his dress, the number and quality of his companions, and his manner of greeting. Sometimes he came with his household slaves and dressed in two or three gowns. He took off his slippers at the entrance to my compound, and made low obeisance. This meant that he was a local official, and I a European official. Sometimes he came with an elder who was a cattle owning kinsman, and he was dressed in a workaday gown; he took off his slippers at my very door. On this occasion he was a kinsman. Sometimes he came with his infant son, and merely sat under the trees till I should join him. Here he was the family man. Sometimes he came alone on horseback and greeted me from the saddle. Here he was an agemate, a close companion. It became necessary for me to interpret these gestures aright if I were to make best use of these occasions. It also became necessary to regulate the tone of my messages to him, or the manner of going to his house. The wearing of shorts or slacks, sun-glasses, and socks, the carrying of a notebook or a camera, the presence of my wife or a servant, the gift of kola nuts, the bringing of news or the style or greeting; all these had to be in keeping with the rôle of the moment to produce the right impression. In our society such gestures and manners take place and are interpreted without our thinking about it. In an alien culture they have to be discovered.

NOBEL PRIZES, 1956

PROF. ANDRE F. COURNAND

PROF. DICKINSON W. RICHARDS Jr

DR WERNER FORSSMANN

Chemistry

The year's Nobel Chemistry Prize has been awarded jointly to Sir Cyril Hinshelwood, Professor of Chemistry at Oxford University, and Prof. Nikolai Nikolaevitch Semenov, Director of the Institute for Chemical Physics of the Soviet Academy. The reward is for research into the kinetics of chemical reactions. Nobel Prizes have twice been awarded in this important subject. In 1901 Van't Hoff received the first Nobel Prize in chemistry for his discoveries of the laws of chemical dynamics, and in 1909 Ostwald was rewarded for his work on catalysis and for his investigations into the principles governing chemical equilibria and rates of reaction.

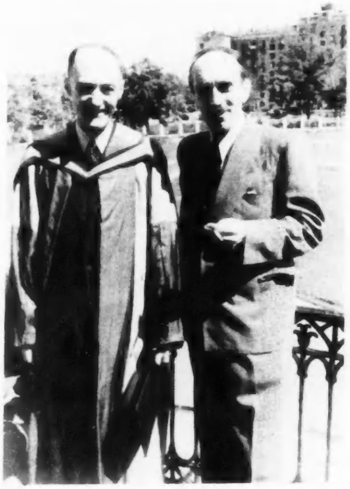
Medicine

This year's Nobel Prize in Physiology or Medicine has been awarded jointly to Prof. André F. Cournand, New York, Dr Werner Forssmann, Bad Kreuznach, and Prof. Dickinson W. Richards Jr, New York, for their discoveries on heart catheterisation and pathological changes in the circulatory system.

In 1929 a young German surgeon, Werner Forssmann, then working in a hospital at Eberswalde, near Berlin, had come to believe that it might be possible to make the interior of the heart accessible to study by introducing into it a urethral catheter. He tested the device on himself in experiments which were by no means without danger. Through a small hole in a vein in the fold of the elbow, he inserted the lubricated catheter, a soft, flexible tube of the kind used to obtain samples from the kidney. Cautiously he pushed it farther in, first up to the collar-bone vein and then through the upper caval vein, until finally it reached to the right heart auricle, x-rays showed Forssmann that the head of the catheter had actually reached the heart. Later publication he pointed out that by injecting a contrast medium through the catheter it ought to be possible to obtain good radiographs of the heart. Forssmann was subjected to depreciatory criticism, and two applications which he made to the Notgemainschaft Deutscher Wissenschaftler for financial assistance remained unanswered.

Nevertheless the seed which he had sown did not fall on stony ground. At Columbia University, New York, Dickinson W. Richards Jr and André Cournand led a group of research workers studying disturbances in the circulation of the blood. The difficulties of using Forssmann's method appeared too great. However, in 1941 Cournand and Ranges published an improved version of the method, which became generally accepted.

Heart catheterisation is important for studying the pressure in the lesser circulation of the human heart and for determining the minute volume of the heart.



The two prizewinners in Chemistry conversing together during the 220th Anniversary Celebrations of the Academy of Sciences of the U.S.S.R. Left, *Sir Cyril Hinshelwood*, right, *Academician Semenov*. (By kind permission of the Society for Cultural Relations with the U.S.S.R.)

Physics

The Nobel Physics Prize for the year goes to three American scientists, Drs William Shockley, John Bardeen, and Walter Houser Brattain. Research has been going on for about ten years at the Bell Telephone Laboratories near New York on various ways of effecting the transistor of the main electrical current. It was surprising that the semiconductor seemed to defend itself against every effort, grouping its own charge carriers into layers which protected the surface against any controlling agent introduced from outside. Shockley and Bardeen thought that the area round the semi-conductor close to an electrode ought to possess specific electrical properties, and these ought to be observable by plotting with probes. Bardeen and Brattain carried out an experiment which confirmed what had been expected about the division of electric fields, but it also proved something else. It happened that during the experiment the tension of the probe was altered. It was close to the main electrode, and the latter was connected in a way which prevented the current from passing except for a small leak. The increase in the leak was surprisingly large.

Continued experiments gave Shockley the idea of building a transistor which should not be limited to very small areas close to points, but which should have an effect over a broad field, in layers of different semi-conducting materials placed one above the other. Treatment with chemicals caused alternate layers in the piles to acquire different charges. By altering the tension in one layer, barriers against the passing of a current are broken down.

The development of the transistor, together with the new method of printed circuits illustrated on this month's cover of DISCOVERY, has enabled very compact electronic equipment, like hearing aids and wirelesses, to be built. Mathematical computers also use transistors, and they have many applications in the control systems of aeroplanes and in military equipment, where they are replacing the common radio valve.

ANNÉE GÉOPHYSIQUE INTERNATIONALE 1957 1958 INTERNATIONAL GEOPHYSICAL YEAR

THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

Details of the artificial satellite project, and other items for upper-air research, were made available at the Barcelona Conference. With the sailing of the Magga Dan *from London in mid-November for the Antarctic, the final stage of the British Antarctic work has begun. The* Magga Dan *carried the British Trans-Antarctic Expedition, leader Dr V. Fuchs, and the Royal Society IGY Expedition, leader Col Robin Smart. H.M. the Queen inspected the* Magga Dan *on November 13.*

"A Nifty Orbit"

The stirring news that the Russians and the Americans are to work in together in elaborating each country's satellite programme and, furthermore, in standardising the means for observing the satellites once launched, was announced at the very end of the fifty-nation Barcelona conference. The statement was made by Prof. Chapman, the IGY President.

The announcement means that the Russians are content to adopt the arrangements for tracking that the Americans have already drawn up. The wavelength has already been chosen on which the radio transmitter within the satellite will automatically communicate information collected during flight to ground stations. It is to be 108 megacycles. The Russians agreed to use the same frequency for their satellite transmissions. This is only one of several common standards, and will mean that the costly equipment of the single stations comprised in the chain to be known as "Moonwatch" can be trained equally on U.S. and U.S.S.R. satellites as each comes within range.

Dr Lloyd Berkner, Vice-President of the IGY organising body and Chairman of the Working Group on Satellites, pointed out in a special interview with DISCOVERY that it was "very likely" that the Russians would try and achieve a polar orbit of some kind. In one possible orbit the satellite could recess in such a way that it would always remain in the sunshine. . . . "That would be a nifty orbit," Dr Berkner remarked; but, unfortunately, particularly difficult to bring off.

The Russians at the Barcelona conference had nothing to add to the simple statement that their country proposed to launch a satellite during the IGY period and that their scientists would "try to maintain this work on the same level as that already undertaken." They agreed to give further information to the Bureau of CSAGI as soon as this was available.

Keeping Track

A long afternoon at the Barcelona conference was devoted to a presentation of the U.S. satellite project. Details of the tracking arrangements are important, since the scientific value of the satellite depends on a satisfactory chain of observing stations round the world, especially now that the Russians have agreed to adopt the same tracking techniques as the Americans.

The Americans also confirmed that "up to twelve satellites" may be launched by them during the Geophysical Year, but there may be "several less". Dr F. Whipple, a leading figure in the American satellite team and Director of the Astrophysical Observatory of the Smithsonian Institution, said that the U.S. "is committed to making one successful satellite flight at least". He emphasised that the first launching would take place during the first six months of the IGY—in other words, *before* January 1958. The fact that a firm date has been given for the initial launching must reflect the scientists' increased confidence in their work as their plans progress.

The first satellite will be placed in an orbit lying between 40° on either side of the Equator. The Russians and the Americans are to co-operate in the planning of further research from satellites, and this will include the selection of other, later, orbits.

The tracking is to be optical and by radio. The siting of the tracking stations mentioned in this note refers only to the orbit of the first satellite; otherwise, arrangements will be identical for all satellites in all orbits, whether American or Russian.

The Astrophysical Observatory of the Smithsonian Institution has developed the optical instrument for this purpose, a modified Schmidt camera "of much better optical quality and field than the standard Schmidt camera", according to Dr Whipple; "it will be able to track a tennis ball in a given orbit!" It has an aperture of twenty inches and a focal length of twenty inches, and the image quality is expected to be good over an area of 30° diameter. It has been designed to be as universal as possible in function, and was not made with any particular orbit in mind. Thirteen of the cameras will be posted at critical points for the observation of the first satellite, six or seven of them in the Americas. It is with these cameras that the *precision observations* of the satellite will be made; they will be crucial in determining the relative atmospheric densities along the orbit—and a number of other geodetic values.

An elaborate and costly radio-tracking equipment known as *Minitrack I* has been developed for establishing the satellite's orbit when it is first launched. Its main function will be to *fix the ephemerides* of the satellite's transmitting system. Once this has been done a relatively simple radio-tracking device requiring only two ground "fixes" and known as *Minitrack II* can take over. The Americans hope that many scientists and even radio-amateurs in countries outside the American continent can be persuaded to join the ranks of "Moonwatch" using *Minitrack IIs* made in their own workshops, and so add to the value of the satellite's flight. It is

Reporters of the IGY Working Groups:

I	World Days	A. H. Shapley
II	Meteorology	J. Van Mieghem
III	Geomagnetism	V. Laursen
IV	Aurora and Airglow	S. Chapman
V	Ionosphere	W. J. G. Beynon
VI	Solar Activity	Y. Öhman
VII	Cosmic Rays	J. A. Simpson
VIII	Longitudes and Latitudes	A. Danjon
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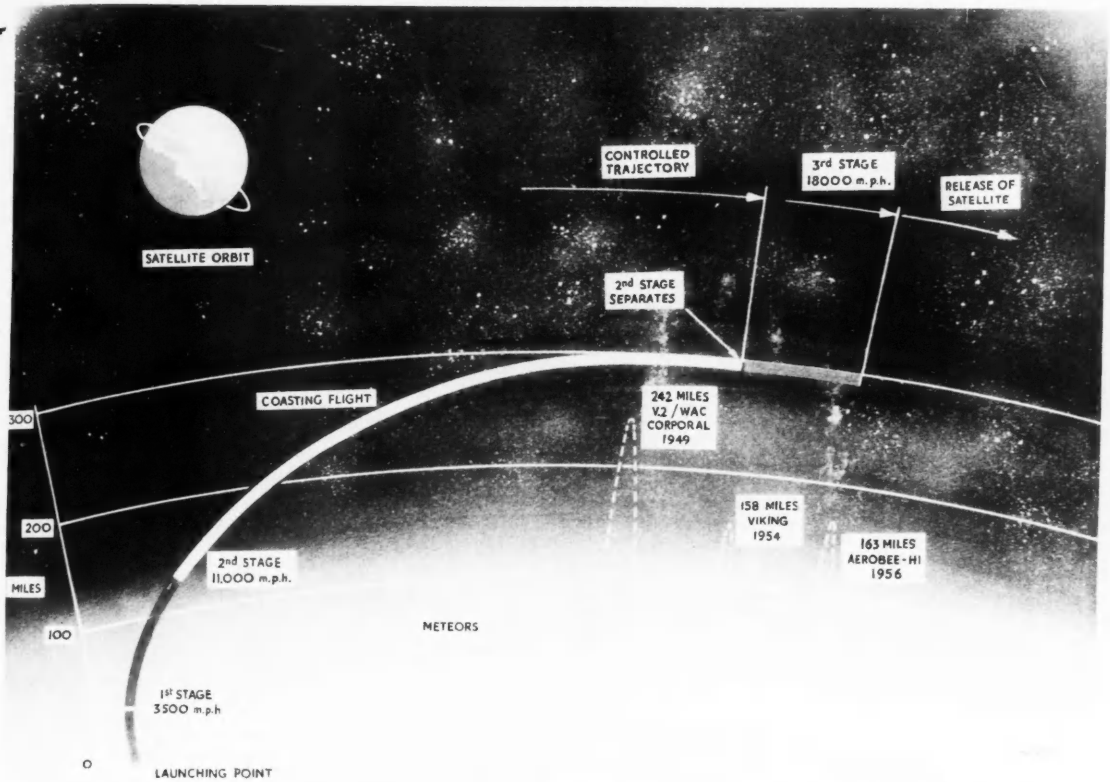
XI	Rockets and Satellites	L. V. Berkner
XII	Seismology	V. V. Beloussov
XIII	Gravimetry	P. Léjay



Launching path of satellite vehicle. Maximum heights achieved by previous rockets, fired vertically through the atmosphere, are shown for comparison. The present record is held by the V-2/WAC Corporal step-rocket which achieved an altitude of 242 miles (and a maximum speed of 5150 m.p.h.) in February, 1949, at White Sands. (*By courtesy of the British Interplanetary Society.*)

understood that ten or so *Minitrack I* stations are to be established.

Of the twelve or thirteen Schmidt cameras intended for tracking the satellite, six are to be made available "on permanent loan" to countries along the first orbit but outside the Western Hemisphere. This is a generous gesture, and the demand is certain to exceed the supply. These instruments cost about $70,000, and they are of great scientific value to astrophysicists apart from their use with the satellites; they are handy for work on comets, for example.

Possible positions for these cameras outside the Western Hemisphere are: Bloemfontein, Woomera, Hawaii, Japan, India or Pakistan, southern China, Iran or Iraq, Egypt, southern Spain or French Morocco or Italy. Of these it is almost certain that Japan will gain a Schmidt, but other successful candidates have not yet been announced.

A "Bulletin for Visual Observers" is now being produced from time to time by the U.S. Satellite Tracking Committee. Copies may be obtained (free) from Dr Fred L. Whipple, Director, The Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge 38, Mass., U.S.A.

Multi-Million-Dollar Rocket Site

The first rockets were fired from the immense specially constructed site at Fort Churchill, Manitoba, Canada, in October and November. This launching ground, which is a joint project of the United States and Canada, cost the financing partner, the U.S., several million dollars. Before the scientists moved in, the area was a waste; many miles of roadway had to be laid through virgin muskeg to bring the men and elaborate equipment to the site. The whole operation was carried through in six months.

Two types of rockets will be used at Fort Churchill, the "Aerobee", and the smaller "Nike-Cajun", which cannot reach beyond the 100-mile altitude.

Fort Churchill was considered a suitable site for the rocket programme because it lies within the Arctic auroral belt where the aurora borealis is best observed.

The table gives a complete account of the United States pre-IGY rocket-testing programme which has been taking place this autumn:

Rocket type	*No. fired*	*From*	*Supervising R's'rch Centre*
Aerobee	1	Churchill	AFCRC
Nike-Cajun	1	Churchill	AFCRC
Nike-Cajun	1	White Sands	AFCRC
Aerobee	4	Churchill	NRL
Rockoon	10	Pacific—off San Diego	NRL
Aerobee	2	Churchill	SCEL
Nike-Cajun	1	White Sands	BRL

AFCRC = Air Force Cambridge Research Center
BRL = Ballistic Research Laboratories
NRL = Naval Research Laboratory
SCEL = Signal Corps Engineering Laboratories

Famous Geophysicist Leads Expedition

Last month Japan's Antarctic base-establishing expedition left from Tokyo for the South. It was embarked aboard the converted lighthouse-relief-ship *Soya* of 2400 tons.

The world-famous Japanese geophysicist, Prof. T. Nagata, of Tokyo University, who is also chairman of the national IGY committee, is leading this advance party and will also be in charge

of the main expedition next year. He is forty-three.

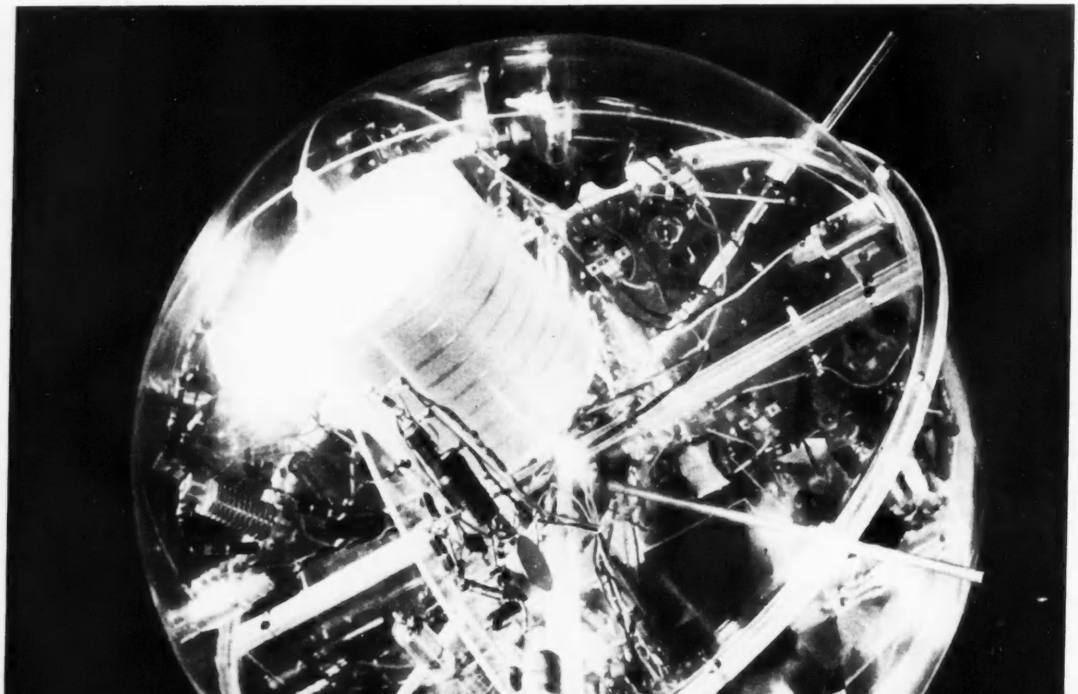
The ship is expected to be off Luetzow Holm Bay, Queen Maud Land, by the beginning of January. The season's work is intended to include a survey of the Luetzow Holm Bay area and the discovery of a suitable route to the Prinz Harald Kyst, where it is hoped to set up the base. February will be spent in building, and in unloading stores, before *Soya* leaves at the end of the month for home. Ten men are to winter over during this first Japanese season. The expedition personnel the following year will be fifty-three, of whom thirty will be trained as Weasel drivers and fifteen as dog-team drivers over and above their scientific and other duties. Two dog-teams are to accompany this season's expedition. Three journalists, one of them a movie-cameraman, will also be of the party.

Prof. Nagata has had a fair amount of expedition experience, though not previously outside his own country. He has made stringent demands in physical fitness and training of his expedition members, and makes sure that he conforms to them himself. Between attending the Paris Antarctic conference (August) and the Barcelona CSAGI conference (September) he joined a week's expedition training in ski-technique in the Japanese mountains. During the period expedition members scaled a 3000-metre peak, returning on skis.

Iran Fills A Gap

The \$80,000-to-\$90,000 IGY programme of the Iranian national committee will fill a large gap in the investigation of geophysical data in the Near East. Very little has been done in this region before, and the Iranians claim that their IGY work far exceeds in scope and cost that of any other Near Eastern participant.

Its chief importance lies in the completing of the geophysical account of the 1,650,000 square-kilometre plateau of Iran which lies between 25° and 40° N and 44° and 63°W. This done, the geophysical properties of the huge land-mass in which the plateau lies can be brought into a transcontinental focus. Up till now a thorough and detailed study of the atmospheric and magnetic properties of the area has not been completed. The programme includes



Earth Satellite. This model of a man-made earth satellite is on view at the American Museum-Hayden Planetarium in New York. The model satellite, which is 18 inches in diameter and weighs 25 lb., was designed and built by Herbert R. Pfister. Encased in a transparent plastic sphere, the workings of the projected artificial satellite are clearly visible.

measurements in meteorology, radioactivity, geomagnetism, seismology, gravimetry, and earth-tides. The gravity base at Tehran will be linked with the international gravity line, and co-operation is envisaged with Iran's neighbours, Afghanistan, India, and Turkey. Iran's IGY programme is under the direction of Prof. Hessaby, Dean of the Science Faculty at Tehran University and a well-known nuclear physicist who worked for some time with Einstein.

The United States' satellite is scheduled to pass over Iran, and tracking arrangements are therefore being put in hand there. There is a possibility that one of the six $70,000 Schmidt cameras that the United States is offering on "permanent loan" to countries well placed for observing the satellite might be installed at Tehran. Whether the Persians, the Egyptians, or the Turks win this handsome prize will depend upon which country can prove that it will make the best use of it.

French Drop on Greenland

The first polar expedition in history to be entirely parachuted-in (that is, without ground control) landed successfully at 72°N 75°W, a point 10,000 feet up and midway across the Greenland ice-cap, this autumn.

This is a preliminary and experimental expedition, a forerunner for the comprehensive several-nation ice-cap expedition planned for 1958, which is to be led by the French explorer, Paul-Emile Victor. (The main expedition was announced in the June issue of DISCOVERY, p. 249.) The all-French parachute party is making seismic studies of the ice and maintaining weather records. They are in touch with the permanent French ice-cap station farther west. Next summer, when their work is done, they will ski the thousand miles to Greenland's east coast to be taken off by ship.

The object of the expedition is partly to test the efficacy of this otherwise economic method of setting up a polar base, and it also has a specific scientific programme. Five men made the drop (only two had previous parachuting experience) and 16 tons of stores were also parachuted; these included a number of delicate scientific instruments. The leader of the expedition is a young French parachute enthusiast, Jean Dumont, who has accompanied P. E. Victor on previous excursions and first caught Victor's eye through his vigorous championing of this unorthodox mode of conveyance.

The party is expected to be away about fourteen months.

Professor Chapman on *Aurora* Watch

One of the resolutions passed at the final CSAGI meeting at Barcelona in September was that countries proposing to join the IGY after the final planning meeting, then being held, would be welcome. So would suggestions to open observation stations after the period begins on July 1, 1957.

Prof. Chapman (IGY President) pointed out that plans and final decisions were much further in advance for the present project than they had been at a comparable stage of the Second Polar Year (1933). He added that a number of participating countries had joined in the Second Polar Year plans after its final planning conference, and that this might well be the case for the IGY. Several countries were hanging back, he thought, through considerations of expense and because they were not sure if they could make a useful contribution.

Efforts were now being made to establish a wide-spread network of *aurora*-watchers. The proposed observations needed no elaborate apparatus or special training and could be made by amateurs. A very considerable number of observers were wanted, well dispersed around the globe.

Aurora experts (of which Prof. Chapman is himself one*) now think that auroral displays are not nearly as strictly confined to the polar regions as usually supposed. They may be seen occasionally even on the Equator, but may wrongly be attributed to other causes.

Men whose profession habitually keeps them up at night, such as sailors and airmen (particularly the latter, because of their wider view), would be likely *aurora*-watchers.

Prof. Chapman thought that auroral observations might provide the solution for those countries which wished to take part in the IGY but could not finance a big programme. Such observations would be very useful, yet need cost practically nothing. If a well-manned, widely dispersed network can be organised it is hoped to glean more information about phenomena related to but distinct from *aurorae*, and which are even less well understood, such as airglow and the mysterious noctilucent clouds. Evidence of world distribution of these phenomena would be valuable.

Any reader of DISCOVERY who wants to participate in the *aurora* watch should communicate with James Paton, University of Edinburgh, for British readers; with Prof. S. Chapman, c/o USNC-IGY, National Research Council, Washington, D.C., U.S.A., for others.

Nuclear Radiation Added

During 1955 the Netherlands national IGY committee suggested that measurements of nuclear radiation in the atmosphere be included in the meteorological programme. Last year the proposal was turned down by the CSAGI Working Group on Meteorology, but became reinstated in rather a different form at a subsequent meeting of the ACIGY. All mention of radioactivity resulting from bomb explosions was dropped in the later version.

During this year other participating countries have become interested in the proposed research—in particular the United States and the four Scandinavian countries (several of which are already embarked on extensive experiments to determine the degree of radioactive fall-out at ground-level).

The resolutions and recommendations of the Barcelona conference were intended to further: (1) the use of radioactive (but non-toxic) material, such as tritium, as a tool for other study (that is, as a tracer to determine the circulation patterns of the air and of the oceans); (2) the widespread but unelaborate investigation of the radioactivity at ground-level during the IGY period, with the hope that this might provide data against which later activity can be measured.

"The principal effort in this programme," it was said, "should be measurements of the gross radioactivity of the air and the precipitation at the surface of the Earth. The sampling techniques for this purpose are simple and analyses can be performed by existing physical laboratories."

A programme of this kind, however, is to constitute a minimum. Where facilities and trained personnel are available the following supplementary experiments are recommended: The analysis of samples for such long-lived radio nuclides as tritium, strontium 90, and cesium 137, at ground and upper levels; and the analyses of short-lived natural radio-nuclides such as radon and thoron. National committees are urged to co-operate in the collection and, possibly, the analyses of samples, and an interim committee is being set up to arrange for the establishment of a network of stations and the standardisation of observational and analytical methods.

Britain was among the handful of countries originally asked to give her opinion as to whether or not research on nuclear radiation in the atmosphere should be included in the IGY programme. She rejected the proposal in its original form on the grounds that results would be too vague to be of value. Asked whether the British national committee was likely to join in with the scheme as now drafted, Dr D. C. Martin, Assistant Secretary of the Royal Society and a member of the national committee, thought it was likely that Britain would participate, so far as existing facilities would permit. A base-line of radiation for a particular period would obviously be valuable, he said.

Correction

In the October issue the Check-list of ships operating in the Antarctic showed, through a slip, the Soviet polar transports *Ob* and *Lena* as possessing 17,000 horse-power. This should, of course, have read 7000 h.p.

* "The *Aurora* in Middle and Lower Latitudes", a draft chapter for the IGY Manual for Aurora and Airglow, by Prof. Chapman, was published by the U.S. National Bureau of Standards (Project 5004), August 15, 1956.

NEW SCIENTIFIC INSTRUMENTS

This feature is designed to provide information about new scientific instruments which have come on the market. The detailed facts in it are the responsibility of the manufacturers, being taken from literature supplied by the makers. The editor will welcome information from manufacturers about new scientific instruments they are putting on the market. As these notes are intended for the large section of our readership composed of professional scientists, etc., we depart from our customary practice and use symbols and abbreviations to the full in order to be able to convey the maximum amount of detailed information.

Viscosity Meter

This meter gives a continuous indication of viscosity and is intended to be used directly on plant in the manufacture of viscous liquids such as oils, resins, plastics, paints, or tomato juice. It may also be used for rapidly testing small samples.

A special two-phase induction motor rotates a drag member in the fluid whose viscosity is to be determined, and provides the measurement signal. Variation in the viscous drag which produces changes in the current flowing in various motor circuits, is indicated on a milliammeter or fed to a potentiometer type recorder. The indication obtained varies approximately as the logarithm of the dynamic viscosity of the fluid.

The rotating drag member is generally a disc, but may be a paddle or a cross bar. Drag members are normally calibrated to cover a range of about one decade; for a greater range extra drag members may be supplied to cover an overlapping part of the required range; and for corrosive or other special fluids drag members may be made to any particular specification.

Dobbie McInnes Ltd., 191–3 Broomloan Road, Glasgow, S.W.1.

Multi-purpose Recorder

The Fielden Servograph Mark II, recently introduced, is an improved version of their original 1950 model electronic recording meter. It is suitable for direct operation from instruments such as pH meters, smoke density detectors, CO_2 meters, beta gauges, and tachometers, and can also be used as a recording voltmeter and ammeter. Its low-power consumption of only a few micro-watts enables it to replace any moving-coil indicating meter. It can be supplied to Indicating Meters BSS 89 Grade 1 accuracy.

Its recording pen is operated by a servo-motorised mechanism controlled by a moving-coil movement in which the normal indicating pointer is replaced by a light metal vane which acts as one plate of a variable condenser. Another similar vane, turned by the servo-mechanism, moves in the same arc as the meter-operated vane, the two being maintained at a constant spacing by an electronic capacity relay which controls the servo-motor. The power available from the servo-motor system is sufficient to operate a robust pen, either capillary tube type or ball point, and it is claimed that the high torque of the pen arm eliminates the tendency of the pen to stick.

Various ranges and models are available, including single and 4-point recorders, recorder-controllers, panel mountings, wall mountings, and portable types.

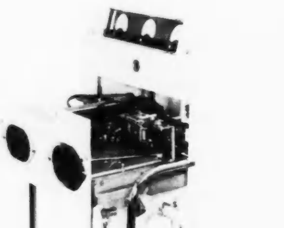
Fielden Electronics Ltd., Wythenshawe, Manchester.

Phototransistor

The Mullard germanium phototransistor OCP71, is of the *p-n-p* alloy type in all-glass construction, and is similar in form to a conventional low power junction transistor; it is stated to be sufficiently sensitive to operate a relay of normal type directly. It can be employed in very simple circuits, for example, connected in series with a relay coil and a 12–18V battery, and is suitable for all kinds of industrial applications such as photoelectric counters, speed measurements, liquid level controls, burglar alarms, tape and punched card readings and so forth. The device is very small, as will be seen from the figure. The dark current at 25°C does not exceed 300μA while the light current is about 5–10mA. The spectral response is peaked in the infra-red but continues into the visible light.

In addition to its small size the special features of the transistor are its low voltage operation, high sensitivity, relatively large sensitive area, robust construction, and ability to respond to infra-red radiation and high speed of response; the maximum frequency of response when the light source is chopped is in the region of 3 kc/s. The device is unsuitable for use above 40° C.

Mullard Ltd., Century House, Shaftesbury Avenue, London, W.C.2.



Rapid hand and clothing monitor.

Rapid Hand and Clothing Monitor

This equipment, Type 1404A, was designed in conjunction with A.E.R.E. Harwell for rapidly monitoring the hands and clothes of people who work in atomic factories, to ascertain how far they have become contaminated with radioactive matter. It is conveniently housed in a compact unit containing five sub-assemblies, each easily removable for cleaning or for replacement. The top unit contains the timing and counting circuits, meters, indicator lights, etc. Below this come the hand units, then the frisking probe unit, the h.t. unit and the e.h.t. unit.

The hand unit contains two ports into which the hands are simultaneously inserted for 30 seconds, during which time an indicator lamp lights. If either hand is withdrawn before this time has elapsed an alarm bell rings; this also happens if the contamination from the β and γ radiation from the hands, which is measured by two thin-walled Geiger counters in the hand compartments, exceeds the safe level shown on the indicating meters in the top unit. A separate meter is provided for each hand. Two frisking probes, attached to the front of the monitor with flexible cable, are each run over the clothes; one contains a Geiger tube to measure the β and γ radiation, the other a scintillation counter for the α particles. A small loud speaker indicates the presence of contamination and the count rate is shown on a logarithmic scale meter.

Philips Electrical Ltd., X-ray Division, Century House, Shaftesbury Avenue, London, W.C.2.

LETTERS TO THE EDITOR

To See Ourselves As Others See Us

Sir:

Dr Ferrier may recognise a chip on the shoulder, but apparently did not heed the coat being trailed nor the tongue in the cheek. In view of his more factual approach, may I quote what, in deference to scientific opinion, I will call a reference, although I hope this will not prevent it being taken as an authority.

Working Party 1/B of The Royal Society Scientific Information Conference, 1948, drew the following conclusion from their investigations (p. 114)

> "The oppressive bulk of the scientific literature is due in part to unnecessary repetition and prolixity in publication. This arises not only from the lack of skill of the author, but also from the fact that the number and size of his publications are often taken as a measure of the merit of a scientist."

As far as I know, railwaymen and lawyers have not needed to discuss the problems resulting from the "oppressive bulk" of writing in their particular specialities. Were either of these groups to hold a conference of the importance of the Royal Society meeting, I assure Dr Ferrier I would gladly hurry from my scientific cloisters in the hope that their findings might prove capable of application in the scientific community.

Like Alan Gee, I will admit that I, too, had grossly oversimplified the situation—the amounts of truth in both our letters are probably roughly the same. I thoroughly agree with him that an objective assessment would be very useful. However, I cannot share his disdain of "mere provocation", since we have seen that it has drawn from Mr Gee himself such a clear statement of beliefs and such a useful proposal. The difficulty, as always, is to find someone who can be objective in a matter of human relations.

CLARE FRY.

Electronic Clerks

Sir:

It seems that your report on "Electronic Clerks" in this country (DISCOVERY, September, p. 356) gives an unnecessarily gloomy picture of British progress in this field. Including the work done on the DEUCE, there are at least three machines in this country carrying out commercial work.

LEO has been engaged for several years on internal accounting work, and the ELLIOTT 405 has been calculating the payroll of its manufacturers for some months past. The first point of interest about this latter machine is that it actually uses a magnetic film unit for file purposes similar to the postulated, but non-existent, one mentioned in DISCOVERY. The second is that two further models are in the commissioning stage, with several more on order for use in a variety of industries and public undertakings.

This, I think, shows that Britain is less "behind in the race for increased business efficiency" than might be assumed from the tenor of your article.

S. L. H. CLARKE.

Boreham Wood, Herts.

Entomological Photography

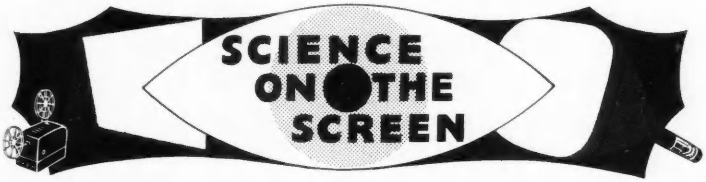
Sir:

I was interested in the letter from Mr Harry Miller in the September issue regarding the restraint of small invertebrates for photographing. Mr Miller will find that if some restless insects are exposed to the fumes of chloroform or ether for a few seconds they will become unconscious and can be handled freely. On being restored to the fresh air they will slowly recover their senses, and it is during this period that they provide the required opportunity. It is, of course, important that the subjects should look as natural as possible, and for this reason it is no use photographing them whilst they remain unconscious.

Another way to quieten some small invertebrates is to place them in a refrigerator for a few seconds. The larvae of many insects, including those of butterflies and moths, which are sometimes restless, will often quieten and remain still for a brief period if the photographer blows on them gently.

GEORGE E. HYDE.

Doncaster.



Nuclear Energy: A Film Strip

By E. L. Hanson and J. S. Strettan. A Film Strip in the Physics Series published by Common Ground (1951) Ltd, 44 Fulham Road, London, S.W.3.

Not the least of the difficulties encountered in "putting over" a concise story of nuclear energy is the way in which the subject divides at an early stage. Passing from a brief account of the theory of the atom, through the importance of the part played by the neutron, to the principles of the nuclear reactor and of the generation of power, the significance of plutonium production has to be put aside to avoid confusion. Yet no story of nuclear energy is complete without reference to plutonium because of its potential as a nuclear fuel of the future. The authors of this film strip overcome the difficulty by recapitulating the theory of the atom, in the middle of their story, laying the emphasis this time, however, on the transmutation of uranium into plutonium. This leads smoothly to a description of the Windscale factory for the production of plutonium and its use in the breeder reactor.

Adverse criticism of this colourful little story is limited to minor parts of the text accompanying the film strip. For instance, reference to chimneys in connexion with nuclear power reactors of the Calder Hall type is likely to offend the sensibilities of those who are at pains to point out that nuclear power plants have no chimneys; they have only vents.

It is to be hoped that the authors will consider the possibility of producing sister strips embracing features of design and construction of nuclear power plant.

W. R. WOOTTON

Colour in a 4-inch Tube

It is understood that a newly developed British tube for colour television has overcome one of the remaining difficulties of electronic design-engineers—the fitting together of the colours on the screen. The new tube is only 4 inches long though screening a 221-inch-square image (previously a screen this size has required a 20-inch tube). The small size enables the "tipping" of the beam to be more readily and effectively controlled. The tube incorporates an ingenious application of electron optics. A system of lenses "tips" the beam of electrons that produce the image on to the screen at different points.

Dr D. Gabor is still working on the tube at the Imperial College.

Atom Films

Two new films on the peaceful aspects of atomic energy are available on loan. They are: "Borax" (20 minutes), describing the research work on a boiling water reactor, followed by its construction and operation. Practical results are shown by electricity from the Borax experimental reactor being supplied to the town of Arco, Idaho; "The Atom in the Service of Humanity" (40 minutes), a filmed report on the U.S.-sponsored exhibit on peaceful uses of the atom, held in Vienna in March 1955. Details may be obtained from the Films Section, USIS, 5 Grosvenor Square, London, W.1.

THE BOOKSHELF

"Frequency Response"

Edited by Rufus Oldenburger, Ph.D. (*New York, The Macmillan Company, 1956, 372 pp., $7.50.*)

This book is a collection of addresses and papers based upon those presented at the 1953 ASME Symposium on Frequency Response, with some additional material, including translations of two Russian papers originally published in *Automatica i Telemechanica*.

In the years since the war, frequency response analysis has found increasing use in the study of closed-loop control systems, and this book provides a useful summary up to 1953. The organisers of the Symposium took a broadminded view of "frequency response" so that the papers range over most of the automatic control field. It is unfortunate that the book's somewhat bald title serves to emphasise a barely perceptible restriction.

Regarded as a general collection of papers on automatic control, this book is of particular interest because it is the first in English since the proceedings of the 1951 Cranfield Conference were issued in 1952. No startling new advances have been made in the subject, but a lot has been done in the application of theory to specific engineering problems, especially in the application of the "describing function" techniques to the frequency response analysis of nonlinear systems; although this was not discussed at the Cranfield Conference, Kochenburger's paper on this subject had already been published.

In the first section of the book, on "Fundamentals", there is a noteworthy paper by R. H. Macmillan entitled "The Frequency-Response Method—A Brief Survey" which is a comprehensive study of the whole field of closed-loop theory. R. Oldenburger writes on "Frequency-Response Data Presentation, Standards and Design Criteria", and puts forward the official ASME recommendations. There is a bibliography of published material by A. M. Fuchs which, unfortunately, is now three years out of date. Another paper by Macmillan is mainly an application study.

The second section is devoted to "Frequency Response Aids" and includes what is probably a unique survey and catalogue of sine-wave generators together with details of their design and use. This paper, by St. Clair and others, will be of interest to engineers faced with the practical job of taking frequency-response runs.

The papers in the section on "Servo, Airplane, and Power System Applications" are concerned with the engineering applications of the frequency-response technique. H. A. Helm gives a detailed analysis of the characteristics of the components in a pneumatic/hydraulic servo. V. Oja studies the frequency-regulating properties of the Swedish power system, probably the largest overall regulating system that has so far been studied. Smith and Triplett contribute a paper on flight methods for evaluating the frequency-response characteristics of aircraft; this is an interesting problem because a full-scale response test cannot be carried out and the characteristics have to be derived from the aircraft's response to some form of transient.

The section on process control starts with a paper by J. M. L. Janssen in which he makes "an attempt to bridge the gap between process-control practice and modern control theory by reducing this theory to its bare essentials". This is by no means a new objective, but Janssen is more successful than most: one has only to read the plain horse-sense of the introduction to realise why. The horse-sense is followed by a clear theoretical explanation of control-system behaviour in terms of "deviation ratio". The following paper by Aikman deals with the frequency-response analysis of a specific process-control problem. The remaining two papers are by Kramers and Alberda and by Eykman and Verhagen and they are concerned respectively with the frequency-response characteristics of dynamic mixing systems and of thermometers.

The section on transient response presents several somewhat rarefied mathematical papers on the relationship between frequency and transient responses.

An important paper by J. H. Westcott entitled "Synthesis of Optimum Feedback Systems Satisfying a Power Limitation" is contained in the section on Optimum Controls. The author considers a servo-system operating from a limited power source and which is required to follow a statistically defined input. Given the transfer functions of the basic elements of the system, he shows how to design the optimum system using the criterion that the mean-square-error is a minimum.

All except one of the papers in the section on non-linear techniques are concerned with the application and development of the "describing function" technique pioneered by Kochenburger; the other being mainly devoted to making an honest theory of it. This is an important technique which applies frequency-response methods to systems containing isolated nonlinearities by considering only the fundamental component of the oscillations. It has never been properly acknowledged that this technique was used by Ivanoff, in his paper to the Institute of Fuel in 1934, for the analysis of an on/off control system. One of the papers in this section (by Goldfarb) is translated from the Russian and applies the technique to several classes of nonlinearity; Chestnut applies it to feedback systems with saturation and dead-band and gives a detailed survey of the behaviour of such systems. Thomas's paper deals specifically with backlash.

There are three papers in the sections devoted to "Sampling Controls" and "Statistical Methods". None of them adds significantly to the literature already available.

The book maintains a very high standard of presentation and careful editing. W. T. BANE

The Oxford Visual Series

Six volumes ("Observing the Heavens"; "The Atmosphere"; "How the Earth is Made"; "How Time is Measured"; "Life in Freshwater"; "Bird Life"). (*Oxford University Press, 1951–6, 11s. 6d each net*)

In attempting to give an appraisal of books intended for children, the adult reviewer must always have grave doubts of his own competence. His standard both of literary quality and factual accuracy, is advanced, he is consciously or unconsciously influenced by the books of his own youth, and he is continually forgetting that an explanation which may seem simple and logical to his own experienced mind may conceal difficulties for a mind which is just as sharp, but less stocked with relevant material.

Another factor which adds to the reviewer's difficulty is that it is very improbable that children read reviews of their books, except in their own class of publication. They are more likely to ask the librarian or teacher for a "good book on rabbits" than consult the literary columns; more usually they imitate the older reader by dipping into a book from the shelves and judging it from inspection—which, after all, is the most satisfying way to choose.

Is there any object, therefore, in reviewing children's books in an adult periodical? To shirk the task would be a disservice to both publisher and reader (adult) who places a certain value on the review columns; it will in the long run be a disservice to the child, who may never hear of a book otherwise and may be deprived of a useful birthday present. And so a review is undertaken, subject to the handicap that it is not written by the young for the young, who alone are the best judges.

The six volumes listed above are, in the publisher's words, "annotated picture-books for young people on subjects connected with physical or natural

science". In later volumes the words "young people" were altered to "beginners", which is a significant change in these days when specialists are so restricted in knowledge that they are mere beginners in subjects outside their own. Another description of the books would be "a collection of illustrated short articles". Whatever the designation, the method of treatment is well suited to the subjects and the reader. The articles are only a few hundred words in length at most, the illustrations are well chosen and plentiful, and the style of writing is clear and simple without being condescending. As Prof. Howe once said: "You do not make veterinary science simple by calling a horse a gee-gee," and the writers of this series have not debased their language in any way to suit a youthful reader.

On reading through the text, one thinks that here is an excellent basis for a series of short talks to science clubs, and the books provide a useful follow-up in a list of "further reading" at the end of the text.

Altogether, from the adult point of view, the series is one that can be confidently stocked in a school library. It will provide subject matter for many essays on science, will answer some awkward questions, and will certainly stimulate interest in any of the branches of science covered by the titles.

From the general to the detailed: "Observing the Heavens", which was the first title in the series, describes the construction of a telescope, its use in observing the Moon, gives star maps of the hemispheres, and finally the dates of observation of the planets. "The Atmosphere" has a section on British weather. "How the Earth is Made" is perhaps the least exciting of the series, but the reviewer's personal inclinations may have coloured this opinion. A youngster might be thrilled by pictures of paleozoic sharks and tables of geological periods, and there is certainly a picture of flies in amber that shows they are no myth.

"How Time is Measured" is excellently done and the description of the marine chronometer and quartz clock is equalled by that of the striking clock; the diagrams would enable the veriest tyro to understand how clocks work.

Water life and air life are the last two subjects, and of the two "Bird Life" is the winner because of its superb photographs and sketches ("Man-raised goslings are not interested in mother goose"). This should convert many youngsters into Peter Scotts, whereas the "Life in Fresh Water" may have to be given a different slant to suit the aqua-lungs and flippers with which the modern child goes exploring.

Each of the volumes has a full coloured frontispiece, and colour is distributed through the pages both as an ornament and a visual aid. On the whole, the series has been planned according to the accepted principles of good instruction: not too many words, plenty of pictures, and something to gain and keep the attention on every page.

It is hoped that the spoken comments of the youthful reviewer will endorse the comments of the adult. G. PARR

It has been suggested to the Editor of DISCOVERY *that parents might like to pass on to others their recommendations of good science books for children. The Editor will be pleased to receive such suggestions, and he will publish them from time to time in the book column. The recommendations should give full title, author, publisher, price, and also fifty words describing the contents, how the material is presented—whether in writing, drawings, or photographs and whether in black-and-white or in colour—and brief reasons for the recommendation.*

Gas Chromatography

C. Phillips (*London, Butterworths Scientific Publications, 1956, x+105 pp., 25s.*)

This book has been written primarily as a guide to those whose work may include the field of gas chromatography. The first two chapters give a broad survey of the techniques generally involved. Detailed discussion of the gas/liquid partition chromatographic procedures occupies the bulk of the text. This is obviously Dr Phillips' particular field, and he succeeds in inspiring the reader with striking resolutions of complex mixtures of vapours. Practical details upon this and upon gas adsorption chromatography are sufficiently abundant to make the book a laboratory manual in its own right. On p. 42 a complex glass unit is described as being "readily constructed in an ordinary laboratory". One can only assume that this constitutes a considerable tribute to the ability of the Oxford University glassblowers.

The reference index is comprehensive, and the addresses of firms supplying specific materials is very useful to those in the smaller, or non-industrial laboratories. The style is concise and readable. Theoretical treatment is kept sufficiently simple to ensure that the reader gives it sufficient attention. R. H. PHILLIPS

Progress in Nuclear Energy

Series 1. "Physics and Mathematics", vol. 1 (*London, Pergamon Press, 1956, 398 pp., £4 4s.*)

The Geneva Conference on the Peaceful Uses of Atomic Energy produced from many nations a bewildering array of nuclear information of all kinds, most of which had previously been classified. Now, for the first time, an attempt has been made to digest this information and to present a comprehensive summary. The present elegant volume contains a number of critical reviews of the more important aspects of reactor physics written by prominent

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experts from the United States, from Britain, and from the Soviet Union. Starting with a most careful account of the cross sections of the principal fissile materials, the volume goes on to discuss modern techniques for the measurement of cross sections generally, the assessment of resonance capture on slowing down of neutrons, and the properties of delayed neutrons which make possible the control of a nuclear reactor. These topics cover most of the basic data of reactor physics; there follows a number of articles dealing with some advanced types of critical assembly and the methods of calculation which have been used to predict and assess their properties. Such articles will be of particular interest to scientists who have not previously had access to highly enriched fissile materials. Throughout the book results are discussed on merit alone, without much attention to their country of origin, as befits a scientific work. Before the Geneva Conference this would have seemed strange indeed to those of us whose work has for so long been shrouded in the mists of secrecy. The fact that it has happened so soon is a worthy tribute to that great Conference. The authors of the articles and their editors and publishers are to be congratulated wholeheartedly upon their labours and upon the speed with which this important operation has been completed.

B. H. FLOWERS

Principles of Embryology

By C. H. Waddington (*Allen and Unwin, London, 1956, x+510 pp. with 186 text-figs., bibliography, and index*)

In this new work Prof. Waddington offers a systematic exposition of the science of embryology (or, as he prefers to call it, epigenetics) designed not only as a textbook for advanced students, but also for research workers in other branches of science. Assuming that the reader possesses at the outset a general knowledge of the elements of morphological embryology, and indeed indicating from what sources this may most conveniently be acquired, he divides his book into two unequal parts: the first concerned with the facts of developmental mechanics, the second with more theoretical treatment of the mechanisms as we can now see them. The first two-thirds of the book, therefore, deals successively with fertilisation and cleavage, the physiology and biochemistry of organiser phenomena, later organ development, growth, and regeneration. In the second part the role of the genes in the epigenetic system is studied, after which come chapters on nuclear-cytoplasmic relations, synthesis of new substances during development, the existence and functions of plasmagenes, and analysis of differentiation and individuation.

Maturity of thought lies behind the assured and elegant style, never unnecessarily obscure, and not overloaded are shown in the maps, but are included with references. Prof. Waddington's is a synthetic mind, able to grasp in a masterly way all the implications of a branch of biology whose philosophical difficulties have daunted many. An embryologist may pause from time to time at places where he might like to have handled the material a little differently; the present reviewer would have welcomed fuller treatment of the Tylerian idea that fertilising phenomena may be the right model for all tissue cohesion, of germ-layer disaggregation experiments, of interactions between germ-layer derivatives separated by semi-permeable membranes, and so forth. This is not of course in any way a criticism.

In the next edition we might be granted the convenience of chapter-numbers printed with the page-headings, and more abundant page, instead of chapter, cross-references. This book is, however, the clearest and best of all introductions to the subject in any European language.

JOSEPH NEEDHAM

The Penguin Atlas

Edited by J. S. Keates (*Penguin Books, 1956, 81 pp. of maps, 75 pp. index, 10s.*)

We submitted this book to two reviewers, a cartographer, and a printer. The cartographer writes: "It is a little masterpiece of compression and selection. Many atlases are spoiled by overcrowding the maps with detail. The editor and designers of this one give the essential facts and names clearly; when the size of a double-page map is no more than 11½ by 7½ inches this is an achievement. I have just tested the atlas against a news item about Tibet and the Russian Central Asian Republics in my morning paper. Out of fifteen place-names mentioned in the paragraph all but two are in the atlas—and even in much larger atlases maps of this part of the world are not usually over-informative.

"Contour lines are not shown, but the method of mountain-colouring used is effective and pleasing; indeed the colour used throughout the maps—except for the few physical maps of the continents, which are rather lurid—helps by its quietness to make the lettering legible. Main railways are shown; roads only in such undeveloped areas as are without railways. In one or two of the European maps the international frontier lines might have been marked more strongly. In extensive areas such as the United States and the Middle East, additional larger-scale maps of particular regions (the eastern U.S. and Palestine, for instance) have been included.

"All the place-names in the maps are given in their 'native' form, but in the Index (15,000 entries) appear also in their traditional English spelling. Thus Napoli, Warszawa, and Thessalonike in the Index as Naples, Warsaw, and Salonika.

"As the price of atlases goes these days, this one is a miracle of cheapness."

The printer writes: "The Penguin Atlas is printed in Sweden and based closely on one already published in that country. Rail communications, but not road, are shown.

"A large number of different scales are used: Britain 1, 2 million, the Low Countries 1, 3½ million, most other European countries 1, 6 million, Russian 1, 8 million, and most other parts of the world 1, 20 million. It seems time to appeal to map publishers in their popular maps to use only two or at the most three different scales so that the relative areas and distances in different parts of the world may more readily be appreciated.

"There is no economic information and the needs of the modern traveller by air have not received enough attention. However, the atlas is probably the best compact one yet produced and the maps of Japan, West Africa, East Africa, the Caribbean, and Brazil are more useful than in many more ambitious atlases."

Brief Notes

The *Notes and Records of the Royal Society of London*, vol. 12, no. 1, price 7*s*. 6*d*. plus 6*d*. postage, contains a number of interesting articles. "The Royal Society and English Vocabulary", by A. D. Atkinson, traces the origins of many scientific words to one-time Fellows of the Society, such as Boyle, Cavendish, Neston, Priestley, Faraday, and Halley. A biographical study of George Boole by Sir Geoffrey Taylor quotes Boole's notice in the window of his shop: "Anyone who wishes to observe the works of God in a spirit of reverence is invited to come in and look through my telescope," a remark which shows how soon those who condemned Copernicus and Galileo were proved wrong, not only from the point of view of scientific accuracy, but also in their fear that the new discoveries would shatter theological belief. W. Kneale, in an article on Boole's algebra of logic, describes the early work which led to the truth tables now used for the exposition of elementary logic.

Spaceflight is a new monthly journal published at 3*s*. a copy by the British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1. The first issue appeared in October and contains the story of how British engineers helped to design America's artificial satellite, with the blueprint for a small 16-ton rocket to carry either a payload of instruments or an inflatable metal-foil sphere into a circular orbit round the Earth. The American Vanguard launching vehicle actually follows closely the design of the British rocket, with its three-stage construction, elimination of guide fins in favour of gyro-controlled

pivoting motors, the use of gas-jet controls for stability after cut-off of the second-stage driving motors, and the incorporation of a spherical body as an artificial satellite. The British Interplanetary Society can claim with some justification to have pioneered much of the present work on Earth-satellites; they have recently announced their intention of training optical teams for "Operation Moonwatch", a programme for the tracking of the satellites. A small observatory is being established in Harrogate, Yorkshire. It is hoped to set up similar optical tracking groups in Australia.

High Duty Alloys Ltd, Slough, Bucks, have published a booklet of technical data on Hiduminium wrought and cast alloys, other engine materials, and rolling-mill products.

The Seventh Annual Report of the Commonwealth Scientific and Industrial Research Organization of Australia for the year ending June 30, 1955, records the following note (p. 140): "A search has been made for evidence of radio emission from the planet Jupiter following an announcement from the United States of America that strong, but intermittent signals . . . had been picked up from it at a wavelength of about 15 m. A radio telescope, having very precise directional characteristics at this wavelength, is required to establish with certainty that such signals are, in fact, coming from Jupiter. A 'Cross' aerial capable of this performance at an adjacent wavelength has been under construction for some time, but is not yet in operation. Strong atmospheric-like signals have, however, been detected intermittently with less accurate equipment, and a search of earlier records taken in 1950–1 shows several periods of severe 'interference' consistent with an origin in the planet Jupiter. In neither case is the directional accuracy sufficient to exclude other possibilities, but these observations lend general support to the idea that powerful radio emissions do emanate from at least one other member of the solar system in addition to the Sun."

Vol. 1, No. 6 of *Nuclear Power*, the Journal of British Nuclear Engineering, price 3*s*. 6*d*., contains an excellent three-dimensional diagram of Calder Hall included in a full article on the first nuclear-fission electric power station. *Nuclear Power* is available from 3 Percy Street, London, W.1.

The first issue of a new journal, *Electrical Energy*, appeared in September, price 3*s*. from 28 Essex Street, London, W.C.2. It is designed for the professional electrical engineer engaged in research, development, design, and manufacture, and is a sister journal to *Electronic Engineering*.

Phoenix House have added two new titles to the "Great Moments" series, books for children which have already dealt with mountaineering, medicine, archaeology, and similar subjects. Now John W. R. Taylor describes "Great Moments in Flying", beginning with the Wright Brothers and Blériot, and arriving via Lindbergh and Byrd at the Sound Barrier. Kenneth Hopkins' "Great Moments in Exploration" chooses from among the multitude of famous explorers, perhaps arbitrarily: Marco Polo, Henry Hudson, Cook, Lord Macartney ("Britain's First Ambassador to China", in 1793), the early explorers of Australia, the Nile, the Sahara, and the Antarctic, and Alain Gheerbrant of the Andes. It seems odd that the various discoverers of the American continents are not included; but perhaps the author has been wise in drawing attention to some lesser-known heroes.

The latest Searle-Molesworth-Willans concoction, "Whizz for Atoms" (Max Parrish, 9*s*. 6*d*.), is more whizz than atoms, but shows some intimate knowledge of spase travail, elektronik branes, translating mashines, and the outmoded ways of teeching childrun to rede and rite. The moral seems to be that "britain will win its export batle" if a certain headmaster can be exchanged for a jumping flea.

FAR AND NEAR

Peaceful Use of Antarctica

According to the Bulletin of the United Nations Information Centre of October 22, 1956, India has asked the General Assembly to call upon all nations to agree and affirm that Antarctica shall "be utilised entirely for peaceful purposes and for the general welfare", and in particular that "the area shall not be used in any manner that would create or accentuate world tensions. . . ." The request is made in a memorandum explaining India's formal request last February that the Assembly discuss at its forthcoming 1956 session the question of the peaceful utilisation of Antarctica. Since that date, the twenty-nation Latin-American group of UN Member States has met on several occasions to discuss the subject of Antarctica.

The memorandum notes that increasing interest in the Antarctic region is shown by the "considerable number of recent expeditions" sent there by various nations. Pointing out that the Antarctic continent covers "about six million square miles", it says that "modern science is likely to reveal many possibilities for the peaceful utilisation of a region hitherto regarded as unproductive". It goes on to emphasise that "any disturbance of the equilibrium of natural forces in this area might lead to incalculable consequences for the world as a whole, involving the deterioration of the conditions for human and other forms of animal and plant life. In view of these facts, and bearing in mind the size of the area, its international importance and the growing interest in it, the Government of India consider that in order to strengthen universal peace it would be appropriate and timely for all nations to agree and to affirm that the area will be used entirely for peaceful purposes and for the general welfare." "All nations", it adds, "should agree further to harmonise their actions to these ends and to ensure that no activities in the Antarctica will adversely affect climatic and other natural conditions." The memorandum concludes by suggesting that the Assembly issue a call to all countries.

New Diving Record

A new world record for deep diving has been established in Norwegian waters. The dive was made from H.M.S. *Reclaim* by Senior Commissioned Boatswain George Wookey, aged 34, of Plymouth, who reached a depth of 600 feet in a helmeted flexible diving-suit, receiving a breathing mixture of oxygen and helium supplied from the *Reclaim*.

The previous world record was established by Petty Officer Diver William Bollard, of the Royal Navy, who reached the depth of 535 feet in Loch Fyne on August 28, 1948.

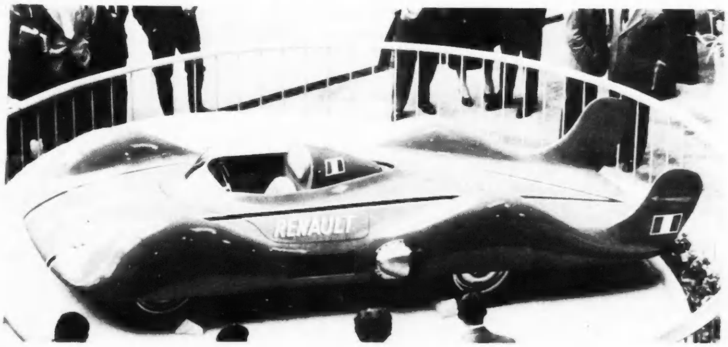
Exceptional Human Endurance

The loss of the m.v. *Arakarimoa*, the auxiliary ketch which was wrecked at Guadalcanal last February after being adrift for two months in the Pacific, is recalled by the announcement that the Queen has approved the award of the British Empire Medal to Ioteba Mataro, the ship's bosun, in recognition of his gallantry and endurance at the time of the disaster. Ioteba Mataro, aged 38, is a Gilbertese from Abaiang Island, Gilbert and Ellice Islands Colony.

When the *Arakarimoa* struck a reef, the only hope was for individuals to try and reach the shore by swimming through the shark-infested sea. Several took to the water, among them Ioteba Mataro, another member of the crew named Teata, and a woman with a one-year-old baby. Ioteba Mataro carried the baby in one arm and swam with the other. After some hours in the water, only Ioteba, with the baby, and Teata were swimming together. The others were either drowned or eaten by sharks. About mid-afternoon Teata said he could hold out no longer. Ioteba told him to place his arm round his (Ioteba's) neck from behind and, thus supporting Teata and still holding the baby, Ioteba continued to swim through the raging sea. At sunset they reached the line of breakers, but the baby had died. Ioteba took Teata, who now could neither swim nor walk, on his shoulders and struggled through the very rough surf to the shore.

Balloon Altitude Record

A research balloon which was launched by the University of Minnesota landed at Georgetown, Kentucky, this week, after being carried swiftly by high altitude winds. Its instruments indicate that it set an altitude record of 143,000 feet. The balloon flight was the first of a series planned by the University. They are designed to open a new area of cosmic-ray studies and to discover new problems connected with space flight.



Gas-turbine Cars

Both the Renault Company of Paris and the Rover Company of Warwickshire have recently released photographs of their gas-turbine cars. The Renault car (*above*) is constructed purely for record-breaking, and no technical details are yet available. The engine of the Rover gas-turbine car (*below*) is a development of the well-known IS/60 industrial gas turbine, and consists of a single-stage centrifugal compressor with a maximum speed of 52,000 r.p.m., driven by a single-stage axial turbine redesigned so that it takes only sufficient power from the gas stream to drive the compressor and fuel oil pumps. A

second single-stage power turbine has been added, which takes the remaining power from the gas stream and drives (through a 7·45/1 reduction gear) the front and rear diffusion units. This reduction gear also incorporates a reverse gear which can be selected by a central control lever.

The plate type secondary surface contra-flow heat exchanger is mounted on top of the engine and takes heat from the exhaust gases to heat the compressed air before it enters the combustion chamber. The exhaust is ducted at about 200 C to a square opening in the top of the boot lid, which also incorporates an ejector orifice to ventilate the engine compartment. At 52,000 compressor r.p.m. the engine develops 110 b.h.p. with a pressure ratio of 3·85/1, a maximum temperature of 830 C, and an air mass flow of 2 lb./sec. The self-sustaining speed of the engine is 15,000 r.p.m.

Catalysis

Academician A. A. Balandin writes in *Pravda* on the question of catalysis in promoting technical progress. Stressing the growing importance of catalysis in the life of mankind, Balandin notes that under the Sixth Five-Year Plan it will be introduced on a larger scale in the production of artificial raw materials and substitutes. Catalysis must be studied further in relation to the oil, chemical, gas, and many other branches of industry.

Were it possible, he goes on to say, to evolve a scientific basis for selecting catalytic agents so that their peculiarities could be learned beforehand, it would be possible not only to improve the existing processes, but to carry out entirely new ones, unknown at present. This would draw chemistry closer to solving a great task of the future, that of ensuring man's basic needs in organic substances by obtaining them from the air, water, coal, oil, and gases.

India's First Atomic Reactor

India's first atomic reactor started operation on August 4 this year. The reactor, of the "swimming-pool" type, is on the island of Trombay, some 12 miles from Bombay and has been constructed entirely through the efforts of Indian atomic scientists and engineers.

Dr Homi Bhabha, President of the Indian Commission for Atomic Energy, said that the reactor was the first of a series planned to give preliminary training to the technicians from India and neighbouring countries who will eventually work in more advanced atomic installations. It will also produce radioisotopes for experimental use in medicine, agriculture, and industry.

Observations of Mars

Commenting on recent observations of Mars, N. P. Barabashov, director of the Gorky University observatory, said that never before had he and his colleagues observed such large bright spots and belts on Mars. There was reason to presume that they were snowfalls or hoarfrost-covered surfaces, spreading over a considerable part of the planet, which had its southern pole turned towards the Earth.

Noting that it was now spring in the southern hemisphere of Mars, he said: "Under the influence of the sun's rays, the huge white polar 'cap' of this hemisphere, consisting of layers of snow, ice, and clouds—which as early as June occupied an area of many thousands of square miles—began to diminish rapidly. By the end of August this dazzling white 'cap' disappeared altogether, and the surface of the zone became dark. That is why we were amazed at the white spots and belts which have now appeared in this region."

The discovery had been communicated to astronomers making observations of Mars all over the world. The first confirmation of like phenomena was received from Wisconsin in the United States.

BCG for School Children

Mr Robin Turton, Minister of Health, thinks that protection given by vaccination against tuberculosis should be offered to more school children. The Medical Research Council's Committee on tuberculosis vaccines shows that vaccination offers a substantial degree of protection to children in their teens.

A Master Year

There is a master year of 273 months, announces Dr Charles G. Abbot, former secretary and now research associate of the Smithsonian Institution.

This period of $22\frac{3}{4}$ ordinary years is due to a recurrent fluctuation in the radiation of the Sun, upon which all terrestrial life depends. The interval is reflected in natural phenomena ranging from temperature and rainfall to the normal human pulse rate.

It has been Dr Abbot's contention that the solar periods basically control the Earth's temperature and rainfall, and he has made predictions which have proved quite successful. The subject, however, is complicated since terrestrial factors also play a part and may at times overwhelm the solar factors.

For example, the Earth's atmosphere, through which the solar radiation must pass, is changed at times by man himself. Conditions before 1900 were different from those at present, owing to the accumulation of extraneous particles in the atmosphere from factory chimneys and from automobile and aeroplane exhausts.

The 273-month period is like a year of the geological ages. Dr Abbot cites evidence, for example, that glacial advances and retreats are intimately associated with it. It is related also to the magnetic period of the Sun and to electrical phenomena in the Earth's atmosphere.

Astronomy Award to Dr Harold Knox Shaw

The Astronomical Society of South Africa announces the first award of the newly established Gill Medal to Dr Harold Knox Shaw, "For outstanding services to Astronomy and in particular to South African Astronomy in the successful establishment of the 74-inch Radcliffe Reflector at Pretoria."

The removal of the Radcliffe Observatory from Oxford to Pretoria and the installation of the 74-inch reflector occupied Dr Knox Shaw's attention for many years, and, owing to many exasperating delays outside his control, he only saw the new 74-inch reflector in operation for the last two years of his term of office as Radcliffe Observer. The Radcliffe telescope is still the largest instrument (recently matched by that at Canberra) in the southern hemisphere. It is extremely well designed, and has proved itself over several years of use.

The Gill Medal commemorates the work of Sir David Gill, one of the most distinguished scientists to work in Southern Africa. Gill was H.M. Astronomer at the Cape from 1879 to 1907, and is celebrated for his numerous contributions to astronomy, notably his determination of the solar parallax, his leading part in the introduction of photography into astronomy, and his design of the Cape Transit Circle, a model for many later instruments.

Ford Foundation Grant to CERN

CERN, the European Organisation for Nuclear Research, has accepted an offer by the Ford Foundation of a grant of $400,000, to be spent over five years, to help in strengthening co-operation in nuclear physics research, primarily with the United States and with other countries not members of CERN. The grant is expected to be used mainly to enable Guest Professors to work with CERN, and to give young scientists opportunities of working in its laboratories.

World's First Solar Electric Station

The world's first solar electric station is soon to go into construction on the Ararat Plain in Armenia. It was designed in the main by the U.S.S.R. Academy of Sciences' Power Engineering Institute. The Ararat Plain was chosen as the site of the station because for duration and intensity of sunshine it surpasses all other parts of the U.S.S.R.

In the centre of a circle of about three-quarters of a mile diameter, bordered with trees to keep the mirrors free of dust, there will be a 130-foot tower. The tower will be rotated by means of a steam boiler whose water will be heated to boiling point by the sun, raising the steam pressure to 30 atmospheres. The steam will then be piped to the turbine of a 1200-kW electric station. Twenty-three circular railway tracks are to be built around

the tower on which automatic trains will carry 1293 large mirrors controlled automatically to face the sun and reflect the sun's rays on to the flat walls of the boiler. When the sun rises its rays will fall on photocells which will switch on the automatic devices to set the trains and the other installations going.

The station will be used experimentally and for industry. Its power will go to drain the subsoil waters from the lowlands and direct them to the fields. It is expected that tens of thousands of acres of land will be brought into cultivation by this means. It is planned to use the exhaust steam for heating hot-houses and flats, and for hot water supplies to baths and laundries.

Extensive utilisation of semi-conductors is planned for the near future. Solar electric stations will then be able to do without steam turbines, receiving energy by the direct transformation of solar energy into electric power.

Science Masters' Association

The annual meeting of the Science Masters' Association will be held in Cambridge from January 2 to January 5, accommodation being provided in the various colleges. The programme includes lectures on such diverse subjects as Disease and Problems of Population, the Chemistry of Fluorine, and Radio Astronomy. Other activities include excursions, showing of films, and exhibitions. Anyone interested should write to the Annual Meeting Secretary, 93 Westbourne Road, West Hartlepool, Co. Durham.

Ship Hydrodynamics Laboratory

The Ministry of Works points out that the detail design and construction of the whole of the Ship Hydrodynamics Laboratory, built for the National Physical Laboratory at Feltham, was under the supervision of the Chief Architect's Division, Ministry of Works. The heating, lighting, power and plant installations were under the supervision of that Ministry's Chief Engineer's Division. A note on the laboratory appeared in our September issue, with a photograph-drawing on the cover.

First Nuclear Merchant Ship

The U.S. Maritime Administration has announced that it is to construct a combination passenger-cargo ship of 12,000 gross tons, to be propelled by atomic power and to be ready for service by 1959. The vessel will have a service speed of 21 knots and will carry more than 100 passengers.

The U.S. Atomic Energy Commission and the Maritime Administration are co-operating in the building of the ship, with the AEC responsible for the nuclear propulsion plant and the Maritime Administration for the ship's hull, its non-nuclear equipment, and the training of the crew. Both agencies have long been studying the feasibility of nuclear-powered commercial vessels. Largely on the strength of their findings, Congress last summer appropriated 42,500,000 dollars for construction of such a ship. Today, there is no longer anything Utopian or visionary about the project. The U.S. Navy has successfully solved atomic ship propulsion and now has two nuclear undersea vessels, the *Nautilus* and the *Seawolf*.

Nuclear ships will have advantages over present-day maritime vessels. The power plant will take up less space than is now given to oil or coal-fired boilers and fuel stocks. The atomic reactor will also be lighter in weight. Perhaps the greatest advantage of atomic propulsion is, however, that a nuclear reactor needs to be refuelled only about once a year. For a merchant ship, that means space saved and quicker turn-around in port made possible, since the time-consuming operation of taking oil or coal aboard is eliminated.

Red-Hot Guided Missile

The penetration of a critical temperature barrier in the development of guided missiles and supersonic aircraft was demonstrated recently in New York when General Electric scientists exhibited laboratory models of revolutionary electronic devices and circuits operating literally "red hot". The achievement was described as a major step towards overcoming the inability of electronic controls to withstand the skin-sizzling heat generated by air friction at extreme speeds.

An equally important "plus" feature of the new electronic circuits is their ability to operate for long periods while exposed to intense nuclear radiation in an atomic reactor.

British Turboprop Airliners

There are two and a half times as many British turboprop airliners on order in the free world as there are foreign—437 as against 173. The foreign aircraft are made up of two types, the American *Electra* offered with Rolls-Royce *Tyne* engines as alternative power plants, and the Dutch *Friendship* which not only uses Rolls-Royce *Dart* engines but British accessories and other equipment. Of the 143 turboprop airliners on order in the United States, 100 are British.

French Château for Unesco

A woodland château near Paris has been donated to Unesco to be used as a meeting place for eminent scientists and scholars to advance the international exchange of knowledge. It is the Château du Bois du Rocher in the Department of Seine-et-Oise. The donors are Mr and Mrs Olof Aschberg, Swedish residents of France, who have long been active in causes concerned with international understanding.

Symposia of scientists, conferences of educators, educational seminars, and other meetings will probably be held in the château.

Erratum

On p. 449 of the November issue of DISCOVERY the caption for the photograph illustrating military design exercises attributed the location of the laboratory to the Camberley Staff College. It should, of course, have been the Royal Military College of Science, Shrivenham, Wilts.

Classified Advertisements

OFFICIAL APPOINTMENTS

APPLICATIONS are invited for pensionable posts as

EXAMINERS
in the
PATENT OFFICE

to undertake the official scientific, technical, and legal work in connexion with Patent applications. There is a small number of similar posts in the Ministry of Supply.

Age at least 21 and under 35 years on January 1, 1956, with extension for regular Forces' service.

Candidates must have 1st or 2nd class Honours in Physics, Chemistry, Mechanical or Electrical Engineering, or in Mathematics, or an equivalent qualification (e.g. A.M.I.M.E., A.M.I.C.E., A.M.I.E.E., A.R.I.C.), but for a limited number of vacancies candidates with 1st or 2nd class Honours degrees in other subjects—scientific or otherwise—will be considered. Candidates over 28 and under 35 on January 1, 1956, will, exceptionally, be admitted without these requirements if they have specially relevant experience.

Starting pay for five-day week of 42 hours in London between £605 and £1120 (men) according to post-graduate (or equivalent) experience and National Service. Maximum of scale £1345. Women's pay above £605 somewhat lower but being improved under equal pay scheme. Good prospects of promotion to Senior Examiner rising to £2000 (under review) and reasonable expectation of further promotion to Principal Examiner.

Application form and further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S 128/56 and stating date of birth.

Selection Board sits at intervals, as required.

Early application advised and in any case not later than December 31, 1956.

EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments. The Civil Service Commissioners invite applications for pensionable posts.

The posts are divided between following main groups and subjects (*a*) Mathematical and Physical Sciences, (*b*) Chemistry and Metallurgy, (*c*) Biological Sciences, (*d*) Engineering subjects and (*e*) Miscellaneous (including, e.g. Geology, Library, and Technical Information Services).

The Nature Conservancy employs Assistant Experimental Officers and is concerned with ecological research.

Age limits: For Experimental Officers, at least 26 and under 31 on December 31, 1956; for Assistant Experimental Officers, at least 18 and under 28 on December 31, 1956. Extension for regular service in H.M. Forces. Candidates aged 31 or over with specialised experience for Experimental Officer posts may be admitted.

Candidates must have at least one of a number of specified qualifications. Examples are Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate. University degree. Candidates taking their examinations in 1956 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general a higher standard of qualification will be looked for in the older candidates than in the younger ones.

Salary (London):

Experimental Officer £925–£1135 (men); £836–£1015 (women).

Assistant Experimental Officer £365 (at age 18) to £805 (men), £715 (women). Starting pay up to £655 (men) or £627 (women) at 26 or over. Somewhat lower outside London. Promotion prospects. Women's scales being improved under equal pay scheme.

Opportunities for further education.

Further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S94-95/56.

Early application advised and in any case not later than December 31, 1956.

SPECIALIST ASSISTANT required by GOVERNMENT OF NORTHERN REGION NIGERIA Agricultural Department for one tour of 12/24 months in first instance, either (*a*) with prospect of pensionable employment, salary scale (including inducement addition) £750 rising to £1554 a year; or (*b*) on temporary terms, salary scale (including inducement addition) £810 rising to £1716 a year plus gratuity at rate of £100/£150 a year. Commencing salary according to experience. Clothing allowance (£45). Free passages for officer and wife. Assistance towards children's passages and grant up to £288 annually. Liberal leave on full salary. Candidates, preferably under 35, must be highly trained in laboratory techniques of either Plant Pathology or Entomology and should possess Diploma of INSTITUTE OF SCIENCE TECHNOLOGY or similar qualification or experience. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3A/35303/DI.

FIELD OFFICER required by WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH for two tours, with prospect of permanency. Salary scale (including inducement addition) £798, rising to £1410 a year. Commencing salary according to age, qualifications, and experience. Outfit allowance up to £60. Free passages for officer and wife. Assistance towards children's passages and grant up to £150 annually towards maintenance in U.K. Liberal leave on full salary after each tour of 12–24 months. Candidates, preferably single, with good education and strong physique, should be interested in bush life. The officer will assist an Entomologist in field research and administration and will have to travel extensively. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3A/43432/DI.

APPOINTMENTS VACANT

RESEARCH SCIENTISTS

COURTAULDS LIMITED offers opportunities for graduate Chemists, Physicists, and Chemical Engineers to carry out original and important work on a wide variety of subjects in its Research and Development Organisation. Neither industrial nor research experience is important because there are first-class training facilities within the Organisation. The Company has large interests in the U.K. and overseas, and its activities are concerned with both the chemical and textile industries.

Many of the vacancies are in new laboratories in Coventry which lie within easy reach of Kenilworth, Stratford, and the Warwickshire countryside. The Company's Sports and Social Club caters for many sports and recreations.

Initial salaries are attractive and comparable with those offered elsewhere; all salaries are reviewed annually. There are excellent prospects in basic research as well as in technical management for those who prefer it after experience in pilot plant and development work.

The appointments are pensionable and there is a Co-partnership Scheme. Housing problems of married men will be given sympathetic consideration.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds Limited, 16 St Martins-le-Grand, London, E.C.1, quoting reference number D.71.

THE RESEARCH LABORATORIES of THE GENERAL ELECTRIC CO. LTD., North Wembley, Middlesex, have the following vacancies for graduates with a good honours degree:

(*a*) PHYSICIST OR PHYSICAL CHEMIST to work in the field of large area germanium and silicon functions, and on the development of semiconductor rectifiers. Some previous experience on semiconductors is desirable.

(*b*) PHYSICIST for research work on the preparation and appraisal of ferrite inductors for telecommunications. A

general degree or higher national certificate might be accepted as qualifications for this post.

(*c*) PHYSICIST who is interested in discharge phenomena, for work of a fundamental nature on light sources.

Candidates for these posts should be not older than 30 years of age, and if under 26 they must be free of National Service commitments.

Please apply in writing to the Staff Manager (Ref. RLO/99), quoting (*a*), (*b*), or (*c*) as applicable, and giving full particulars of experience, qualifications and age.

RESEARCH CHEMIST
CANADA

COURTAULDS (CANADA) LIMITED requires a Physical Chemist with four or five years research experience to undertake important work in the field of cellulose chemistry at the Company's Research Centre in Cornwall, Ontario. Only men with good Honours degrees need apply.

Candidates should write giving full personal particulars and experience to the Director of Personnel, Courtaulds Limited, 16 St Martins-le-Grand, London, E.C.1, quoting reference number G.68.

SUB-EDITORIAL ASSISTANT required by London publishers. Young man or woman (not necessarily graduate, but with good cultural background) interested in scientific and technical literature. Bias on mechanical engineering side preferred. Commencing salary £500 p.a. Apply Box No. D.1535, Aldridge Press Ltd., 27 Chancery Lane, London, W.C.2.

LONDON COUNTY COUNCIL

PADDINGTON TECHNICAL COLLEGE. Assistant Grade B mainly for C. & G. intermediate and final science laboratory technicians courses. Must be able to offer at least two of the following subjects: Chemistry, Physics, Biology, Calculations, Drawing, Workshop Practice, and have had good laboratory experience (industrial or educational). Burnham F.E. salary scale £650×£25–£1025 plus London allowance and additions for qualifications training and experience. Application forms from Secretary at College, Saltram Crescent, W.9, returnable December 14, 1956. (2222.)

LECTURES AND COURSES

FARADAY HOUSE
ELECTRICAL ENGINEERING
COLLEGE

A THREE-YEAR COURSE, commencing each term, in Electrical Engineering to qualify for Associate of Faraday House and Graduate of the Institution of Electrical Engineers, followed by one year's practical training in Industry to qualify for the Diploma of Faraday House. For Prospectus apply to Department "E", Faraday House Electrical Engineering College, 66 Southampton Row, London, W.C.1.

UNIVERSITY OF LONDON

DEPARTMENT OF EXTRA-MURAL STUDIES

TWO University Extension Courses:

(1) The Natural History of Insects (Ten lectures) by Prof. O. W. Richards, M.A., D.Sc., T. R. E. Southwood, B.Sc., Ph.D., P. T. Haskell, B.Sc., Ph.D. Mondays, weekly, beginning January 14, 1957, at 7 p.m., at the Linnean Society's Meeting Room, Burlington House, Piccadilly, W.1. FEE: 15*s*.

(2) Storms, and Prospects for their Control (Six lectures) by F. H. Ludlam, D.I.C. Thursdays, weekly, beginning January 17, 1957, at 6.45 p.m., at the Imperial College of Science and Technology, Meteorology Department, Exhibition Road, South Kensington, S.W.7. FEE: 7*s*. 6*d*.

Tickets for both courses should be obtained from the Deputy Director (Ex. D.), Department of Extra-Mural Studies, University of London, Senate House, W.C.1, to whom further inquiries should be addressed.